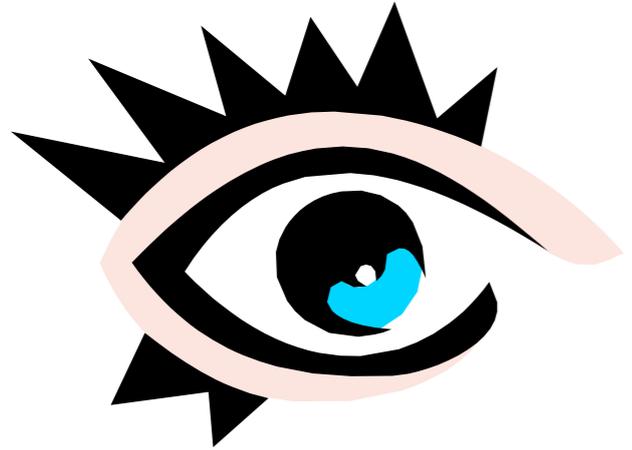


3D modeling of genomes and genomic domains: an overview.

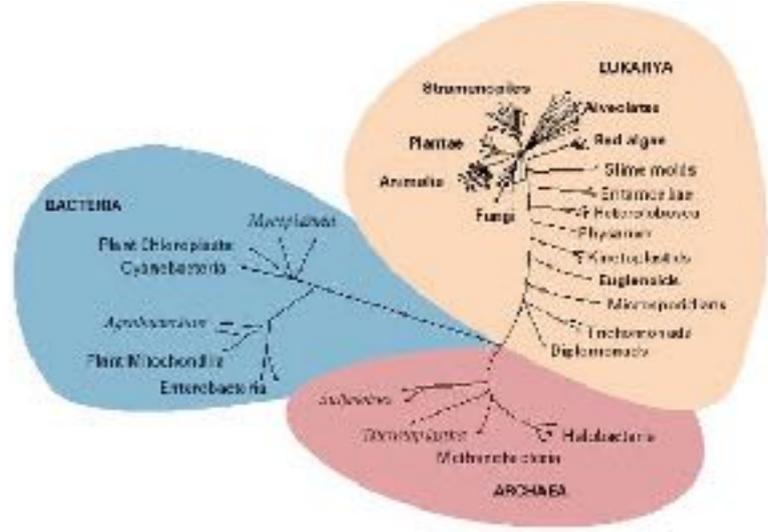
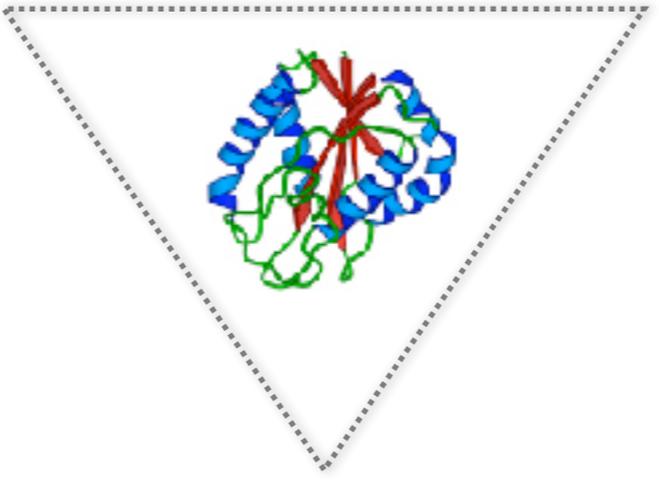
François Serra, Marco Di Stefano & Marc A. Marti-Renom
Structural Genomics Group (CNAG-CRG)



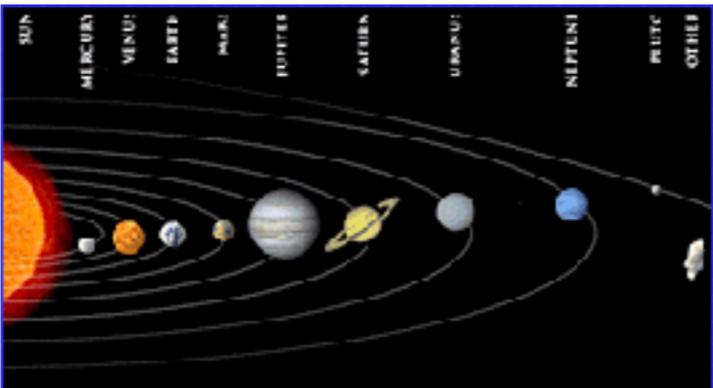
Data groups



Experimental observations



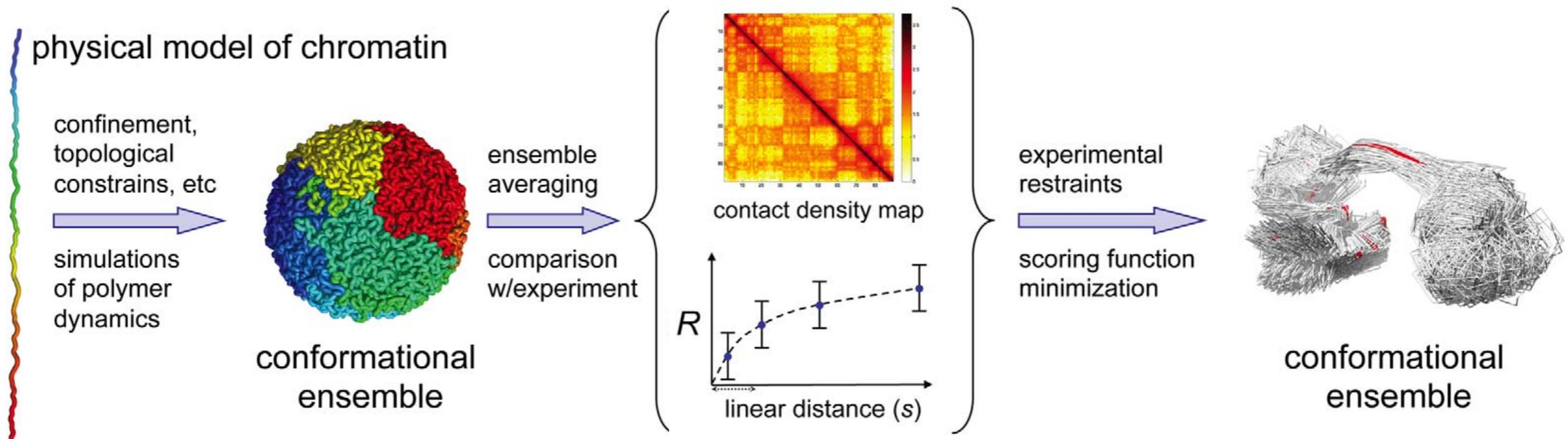
Statistical rules



Laws of physics

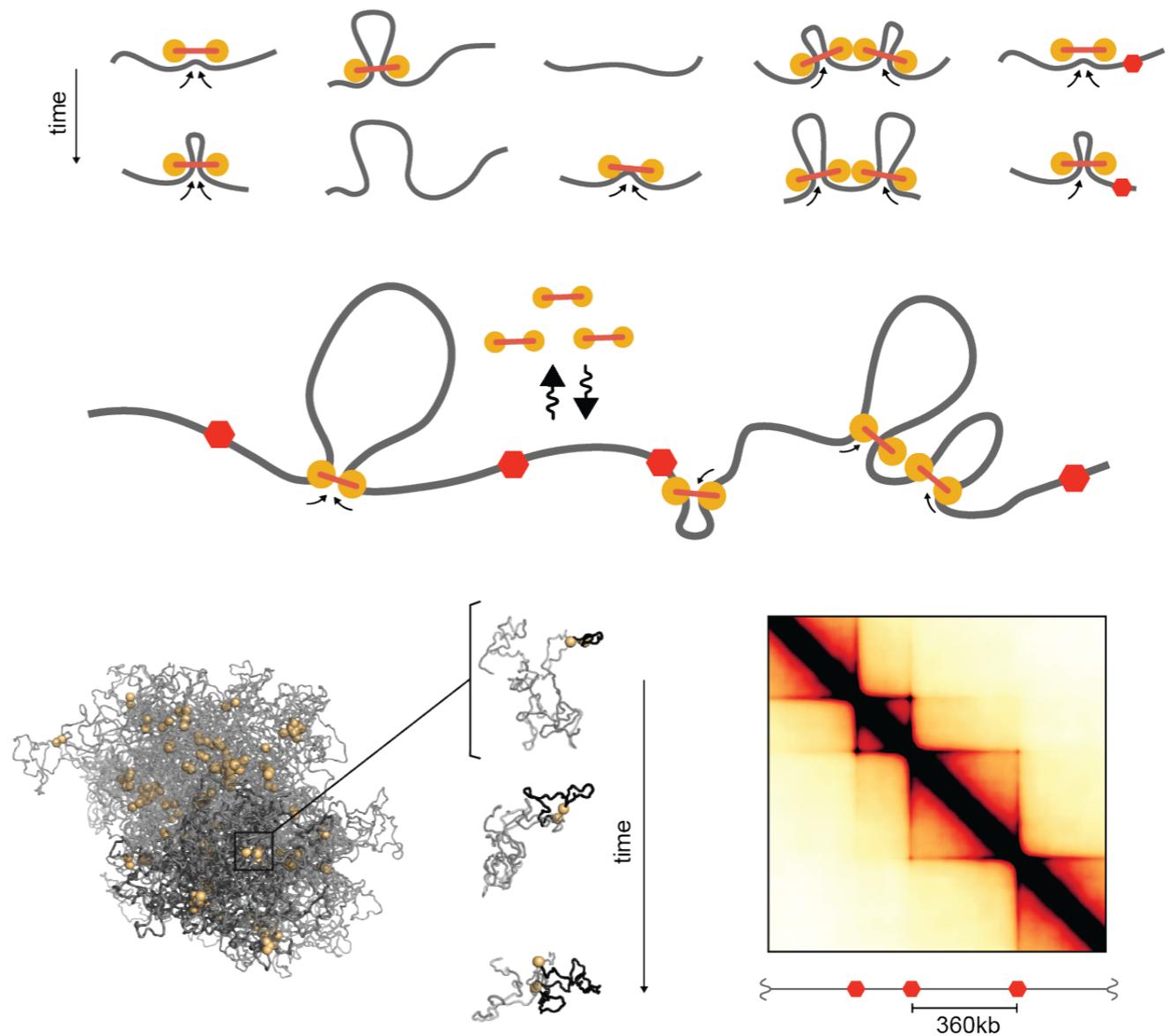
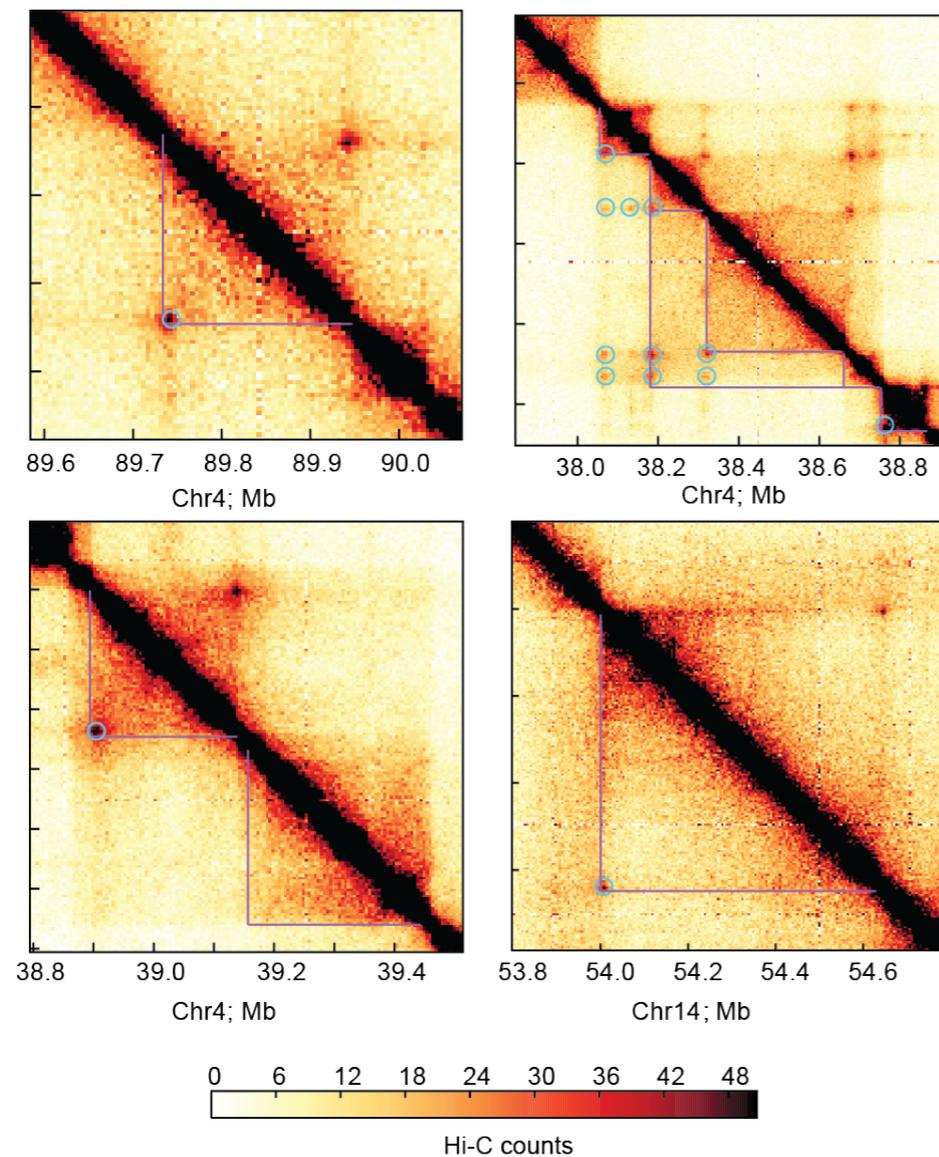
Modeling Genomes

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

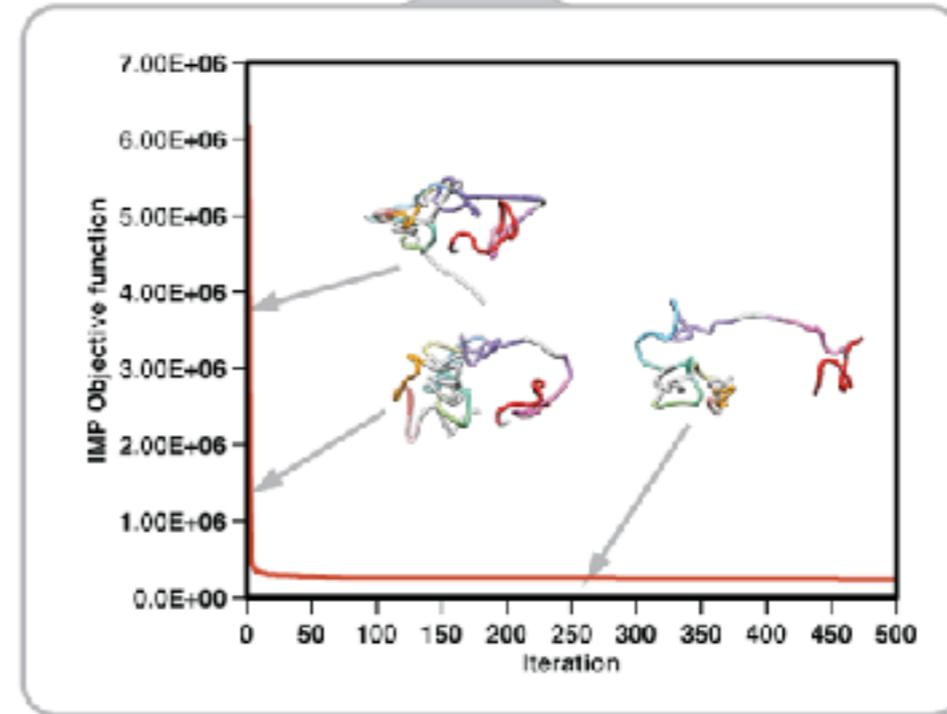
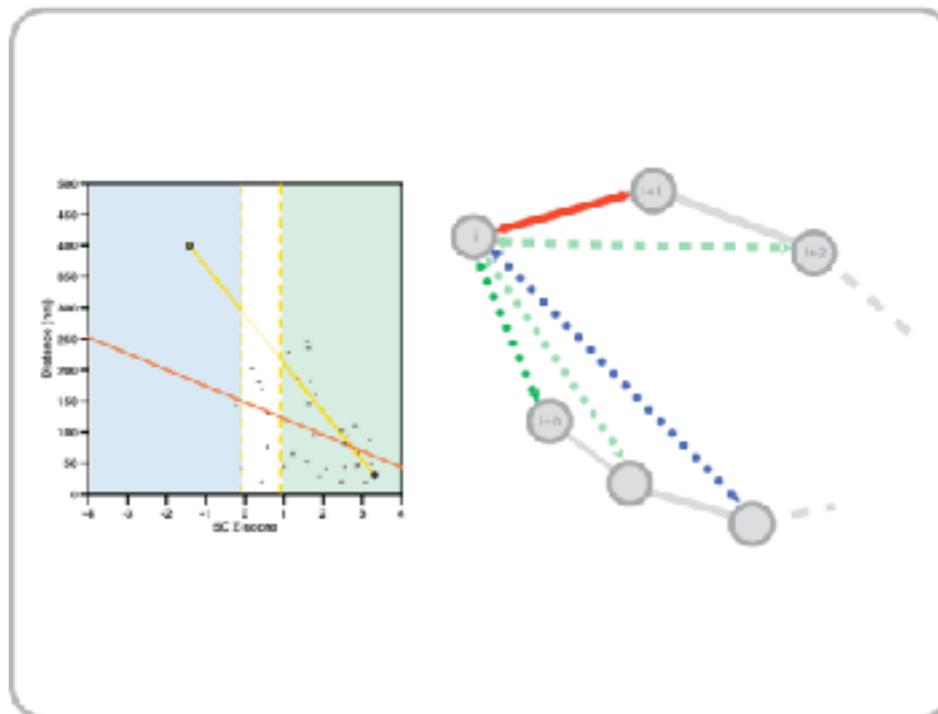
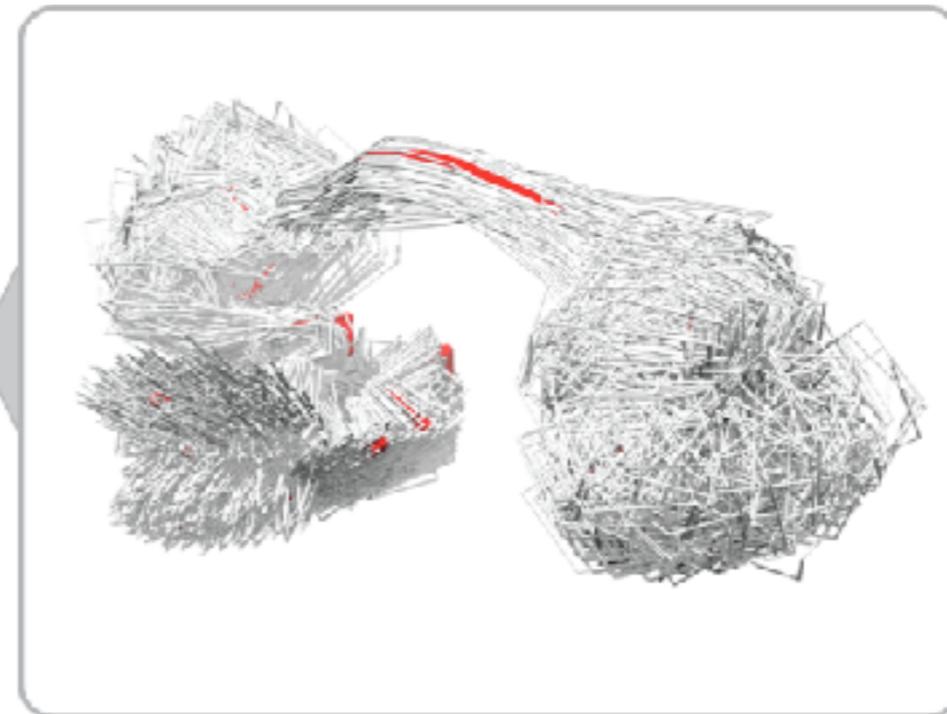
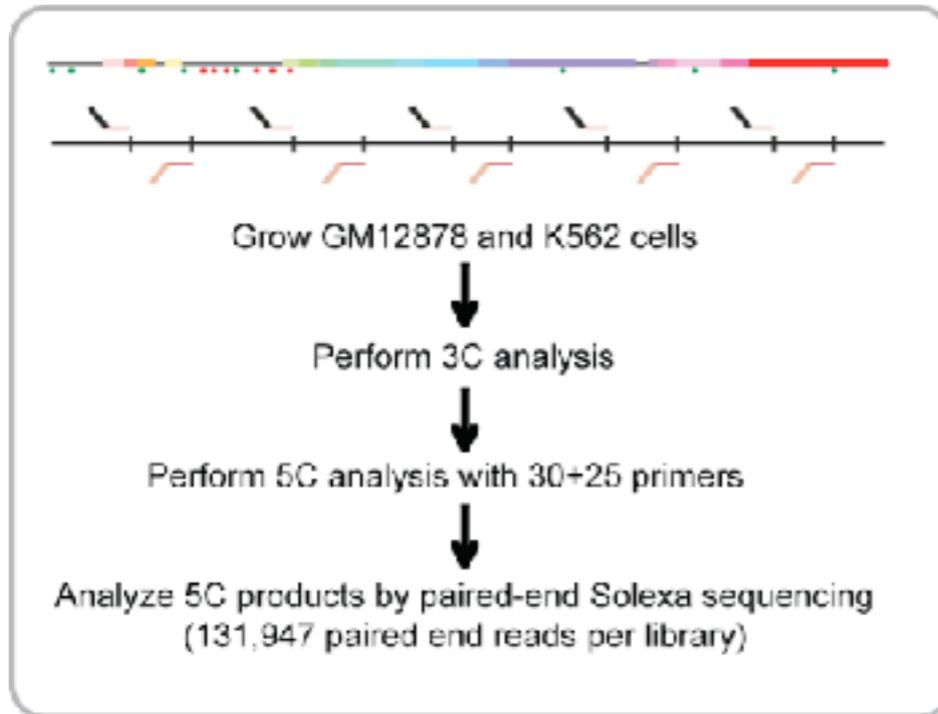


Level V: Loop-extrusion as a driving force

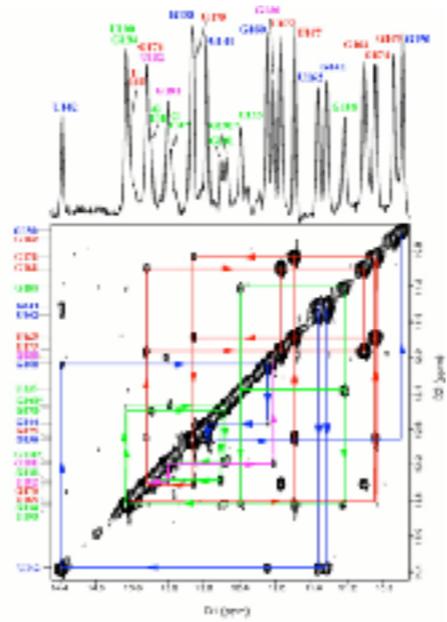
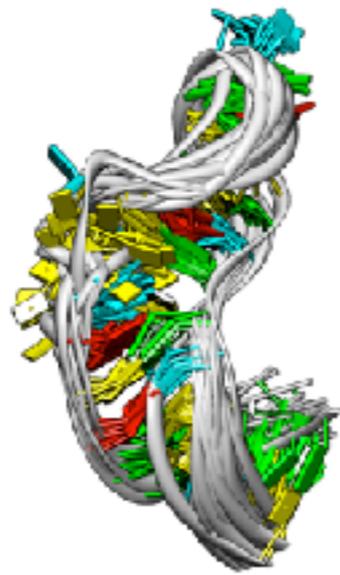
Fudenberg, G., Imakaev, M., Lu, C., Goloborodko, A., Abdennur, N., & Mirny, L. A. (2015).
Formation of Chromosomal Domains by Loop Extrusion. bioRxiv.



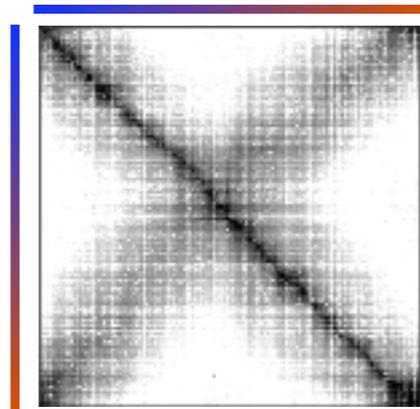
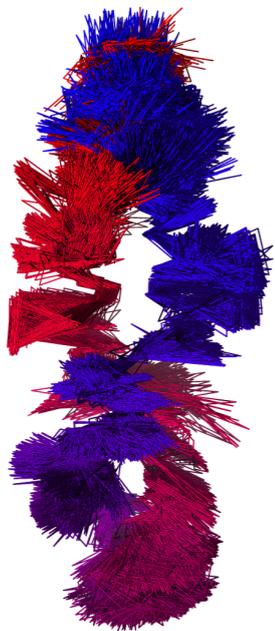
Experiments



Computation



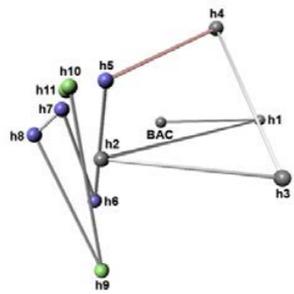
Biomolecular structure determination 2D-NOESY data



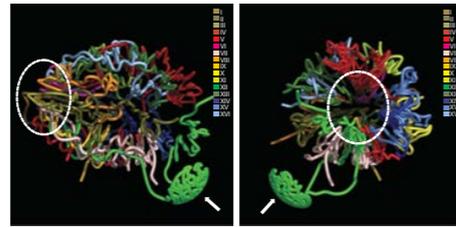
Chromosome structure determination 5C data

3D modeling of genomic domains: other methods

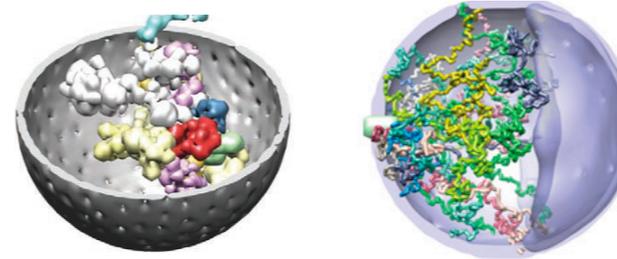
Jhunjunwala (2008) Cell



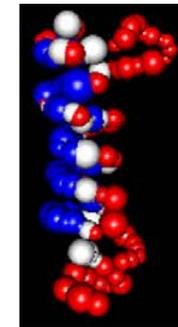
Duan (2010) Nature



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

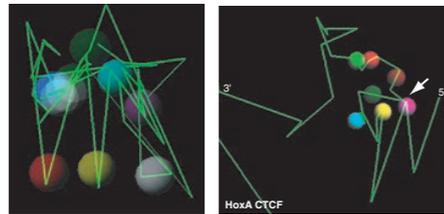


Hu (2013) PLoS Computational Biology

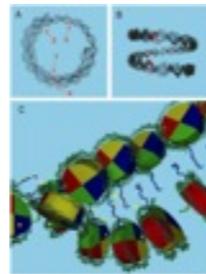


2008

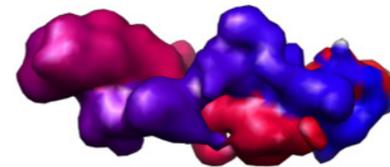
2014



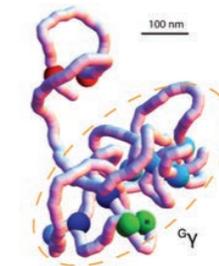
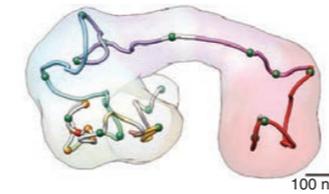
Fraser (2009) Genome Biology
Ferraiuolo (2010) Nucleic Acids Research



Asbury (2010) BMC Bioinformatics



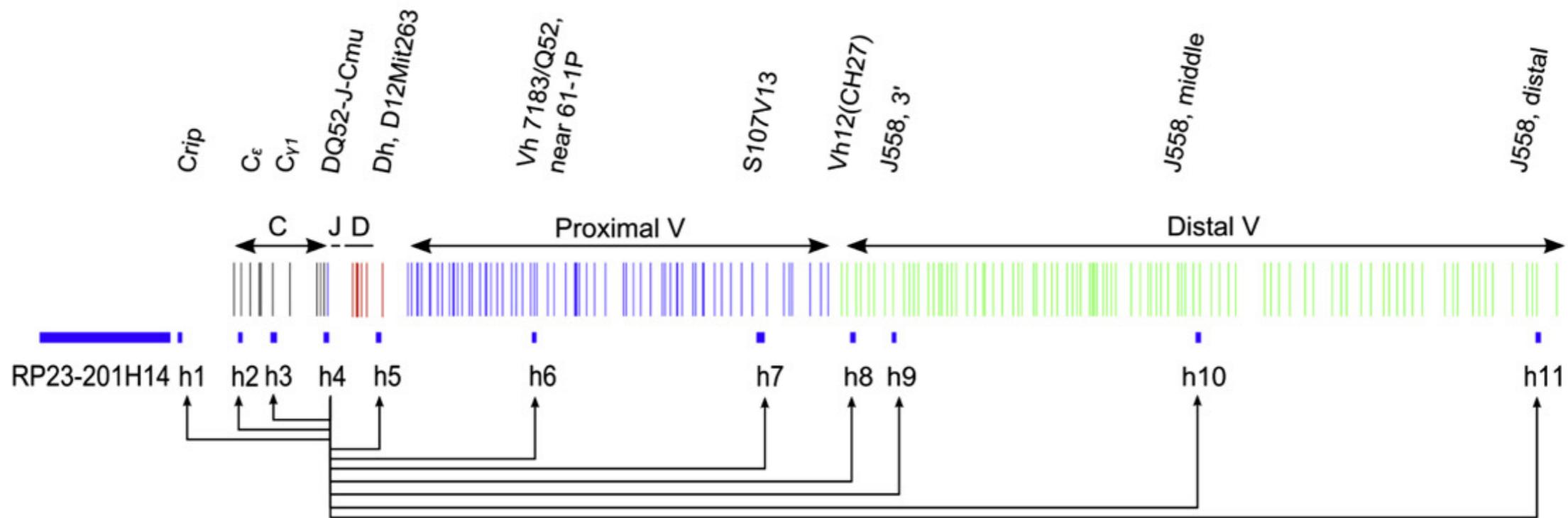
Baù (2011) Nature Structural & Molecular Biology
Umberger (2011) Molecular Cell



Junier (2012) Nucleic Acids Research

The 3D structure of the IgH-chain locus

Jhunjhunwala et al, (2008) Cell

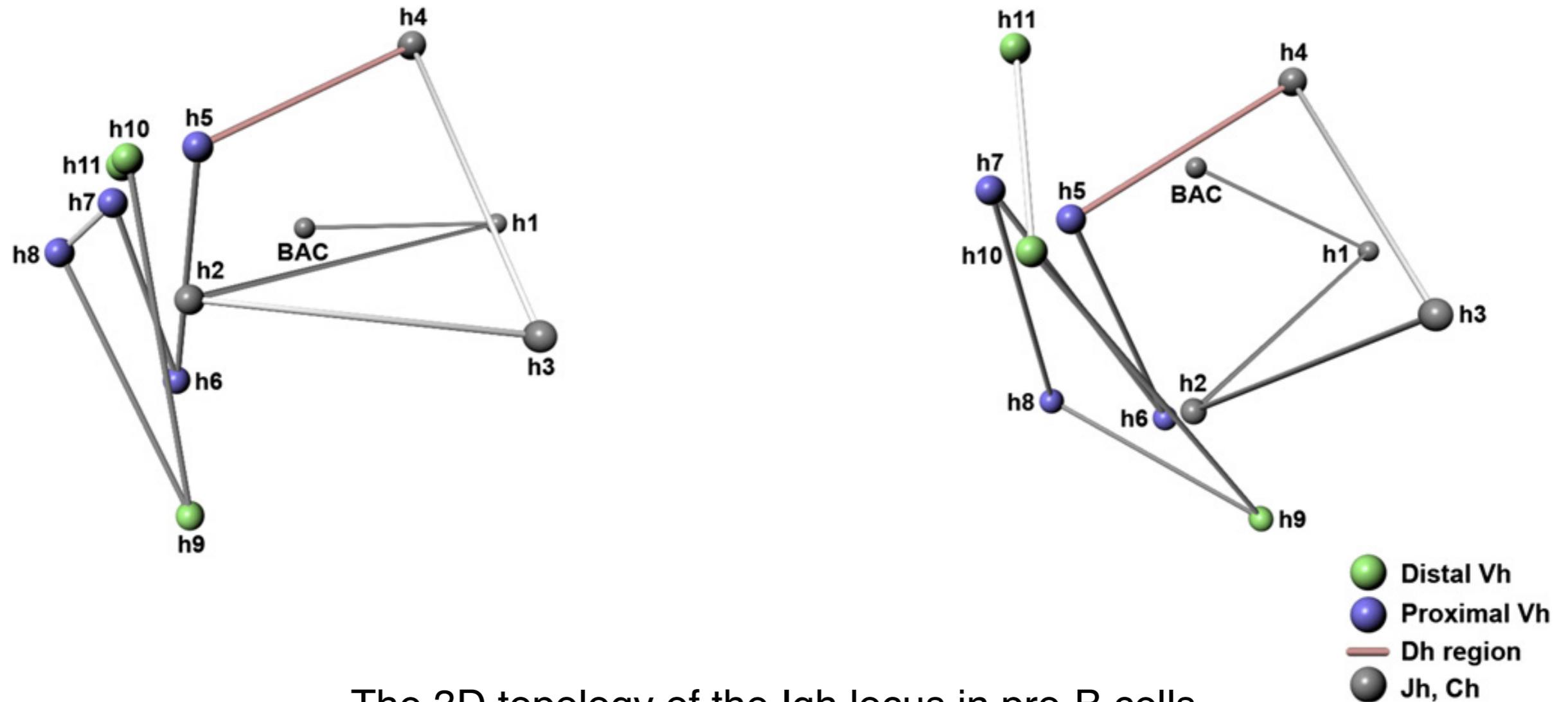


Genomic organization of the Igh locus

Adapted from Jhunjhunwala et al, (2008) Cell

The 3D Structure of the IgH-Chain Locus

Jhunjhunwala et al, (2008) Cell

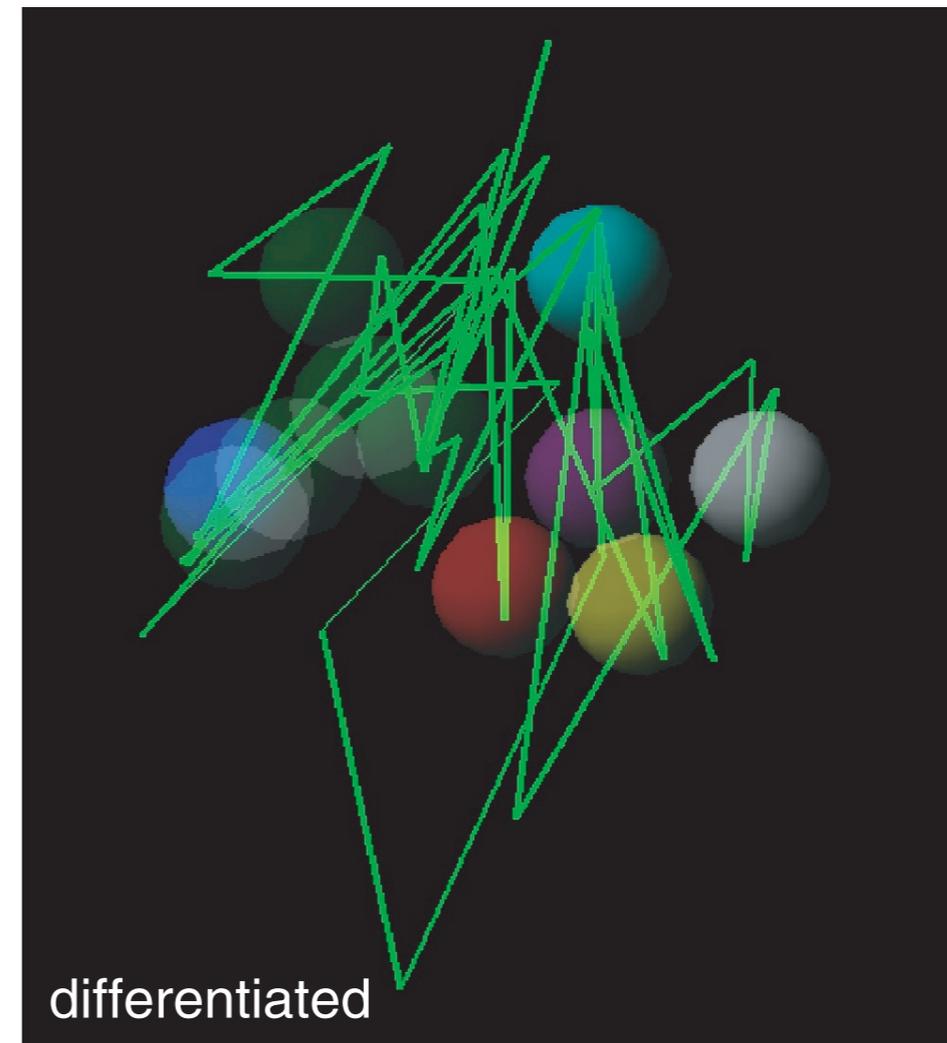
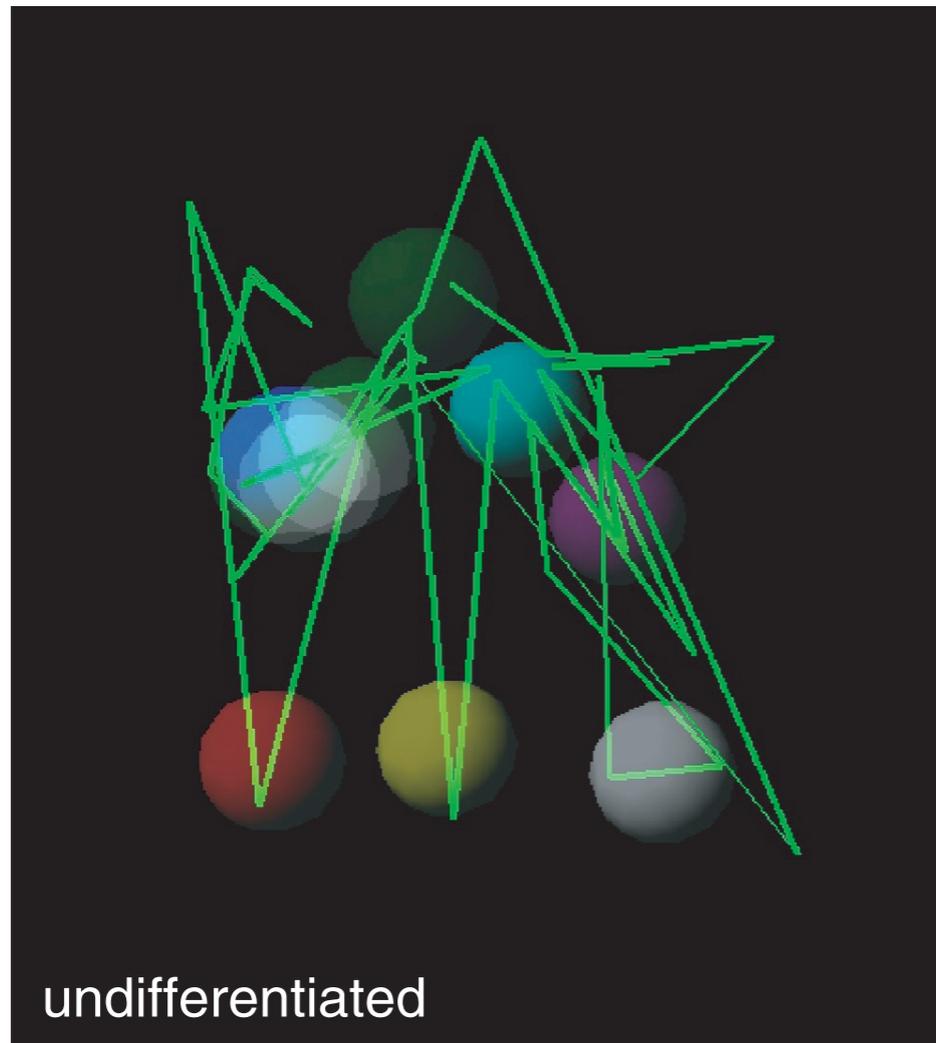


The 3D topology of the Igh locus in pro-B cells

Adapted from Jhunjhunwala et al, (2008) Cell

Chromatin conformation signatures of cellular differentiation

Fraser et al, (2009) Genome biology



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

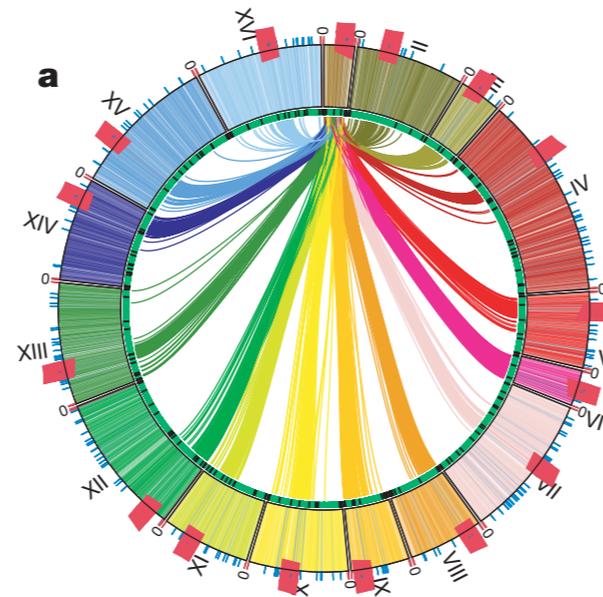
Three-dimensional models of the human *HoxA* cluster during cellular differentiation

Adapted from Fraser et al, (2009) Genome Biology

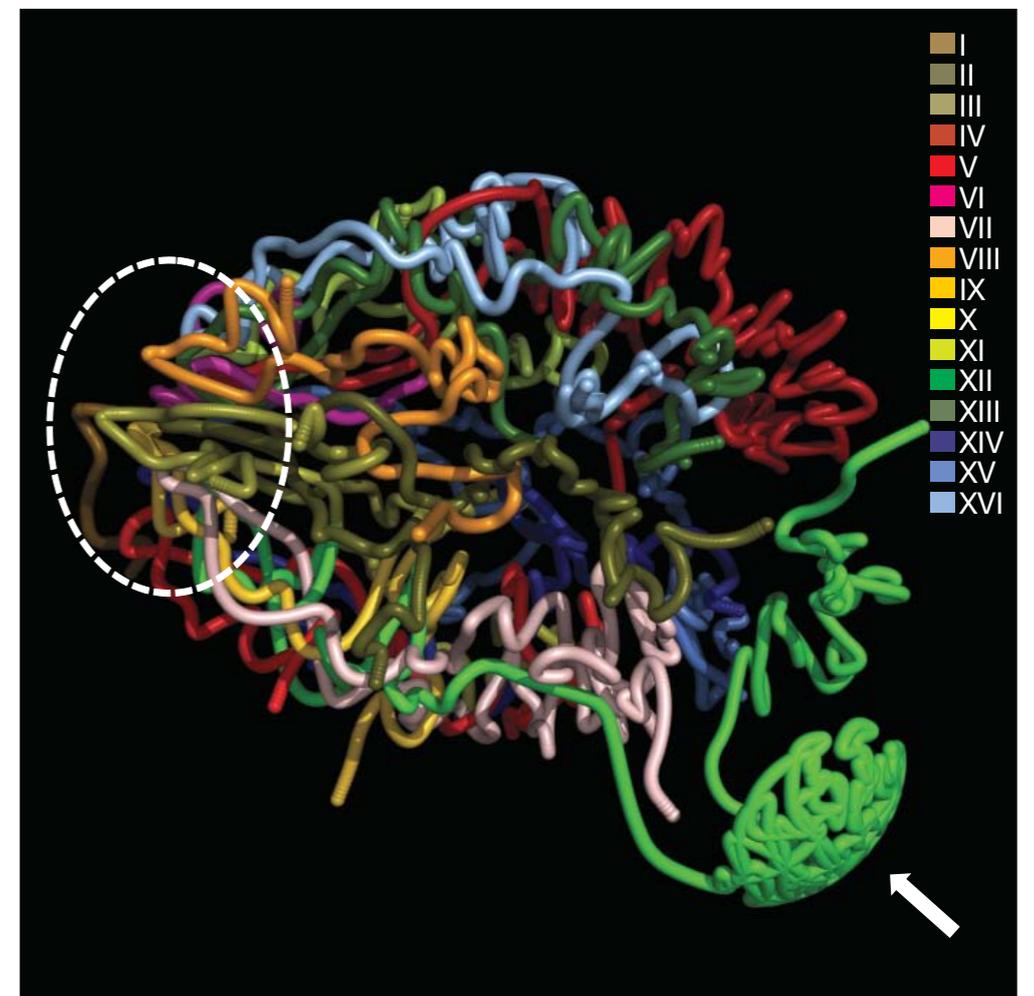
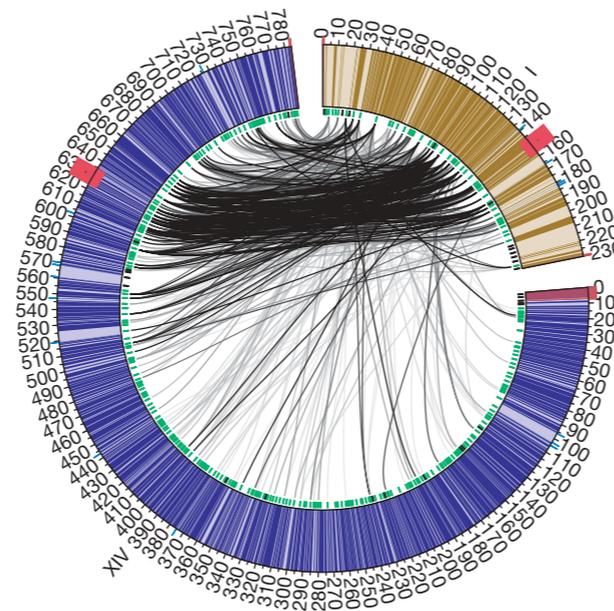
A 3D model of the yeast genome

Duan et al, (2010) Nature

Chromosome I
vs all

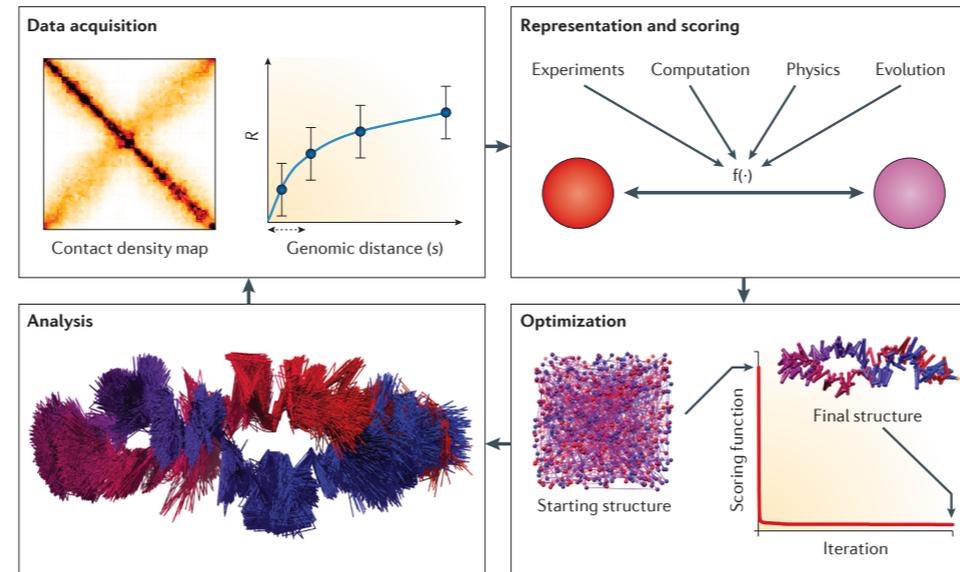


Chromosome XIV

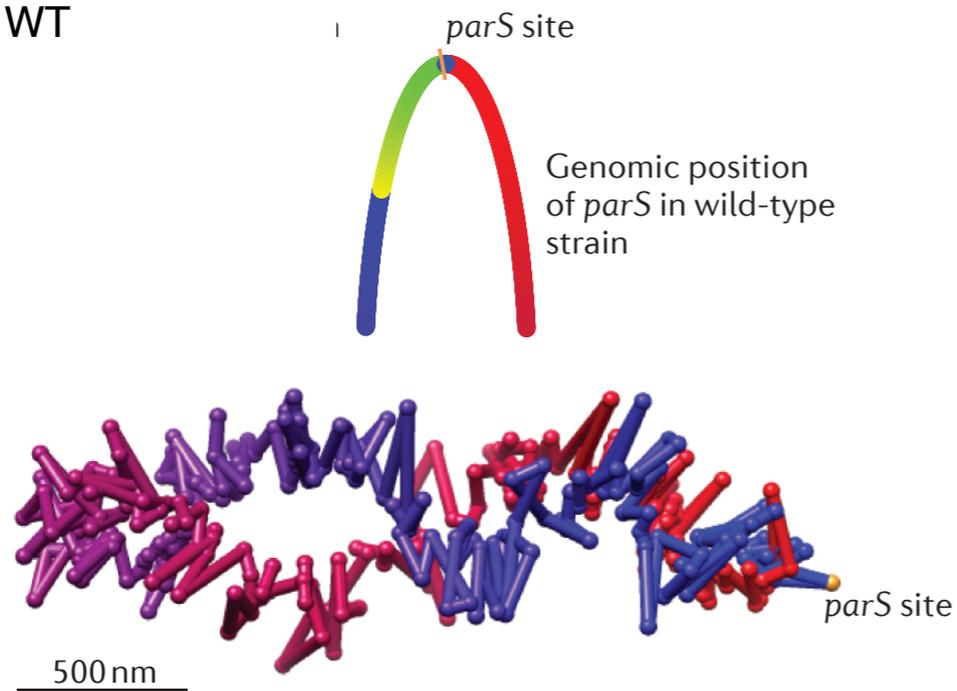


Adapted from Duan et al, (2010) Nature

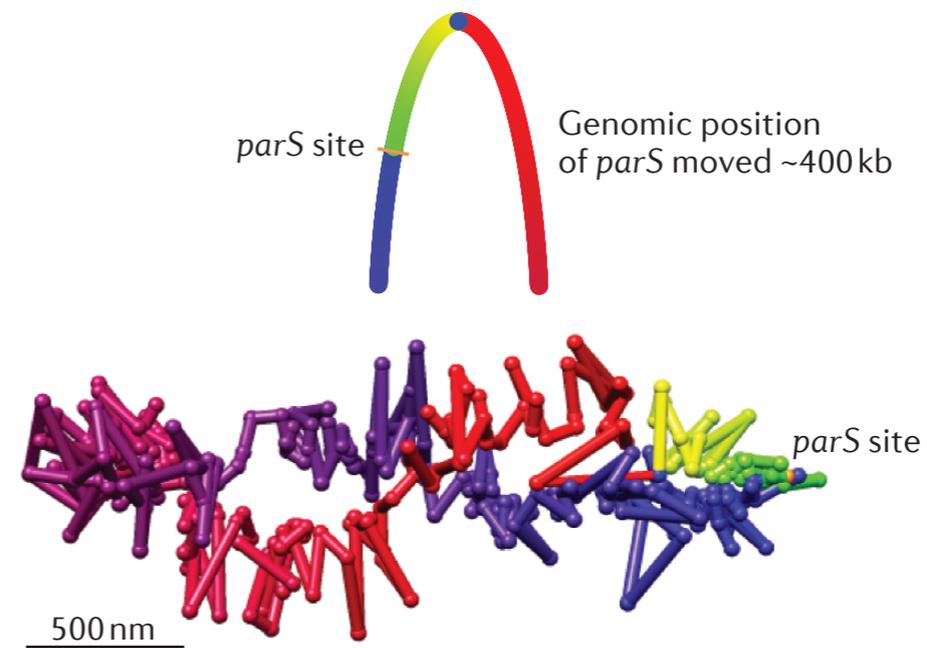
Restraint based models



WT



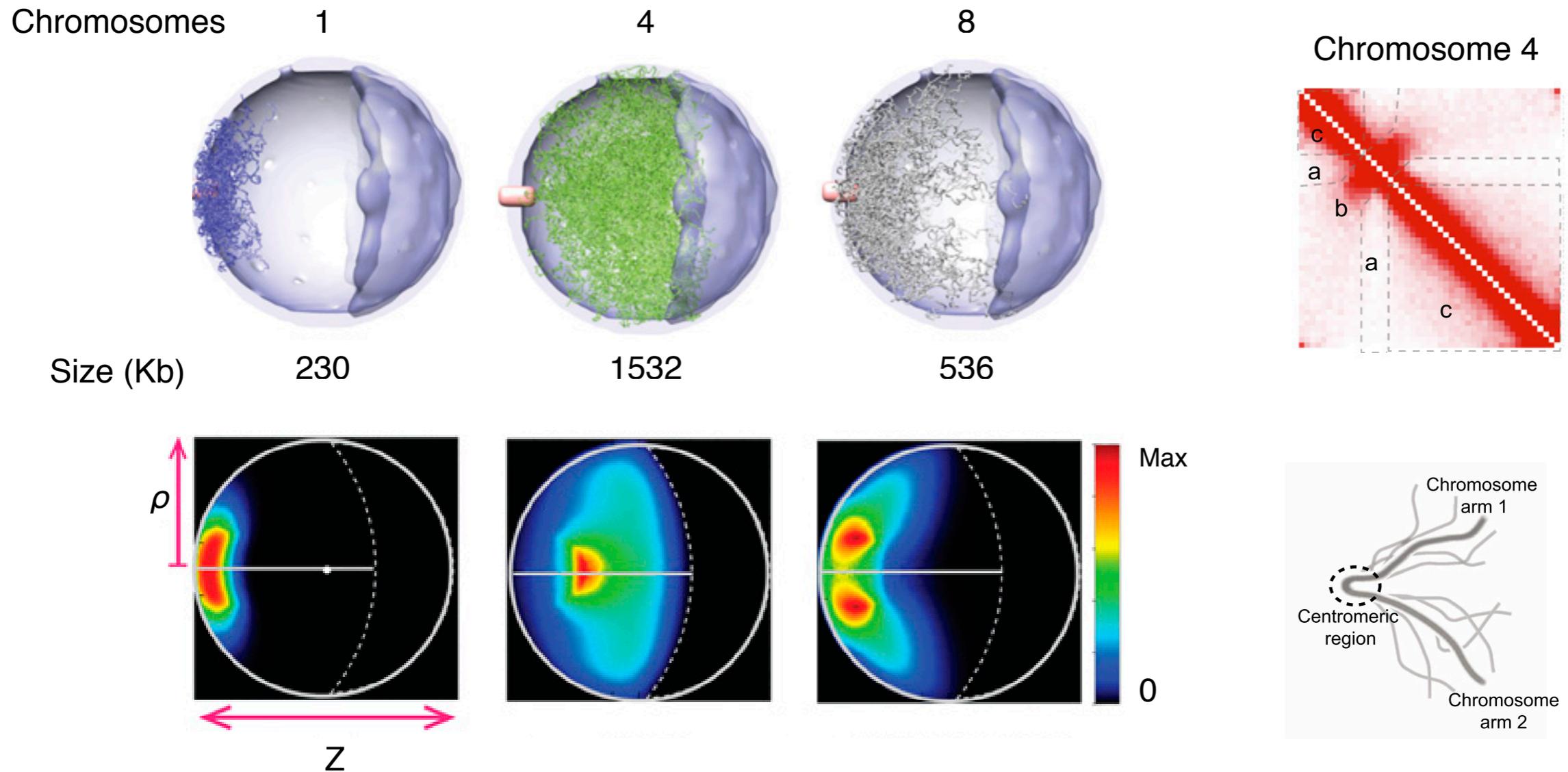
ET166 strain



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

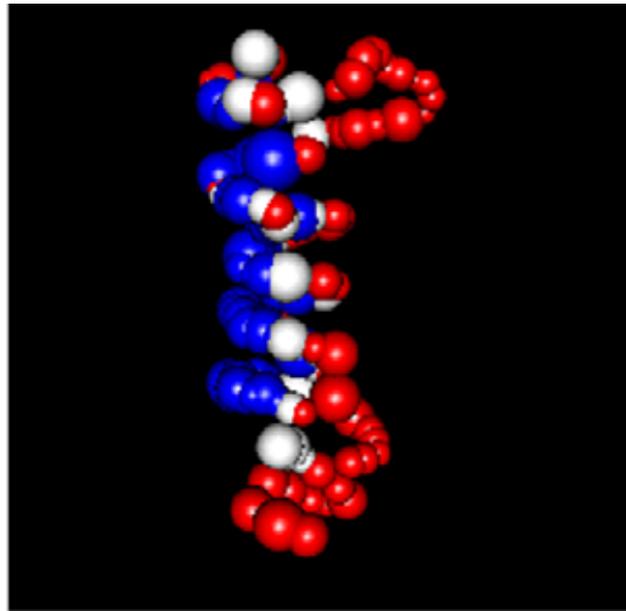


Adapted from Tjong et al, (2012) Genome research

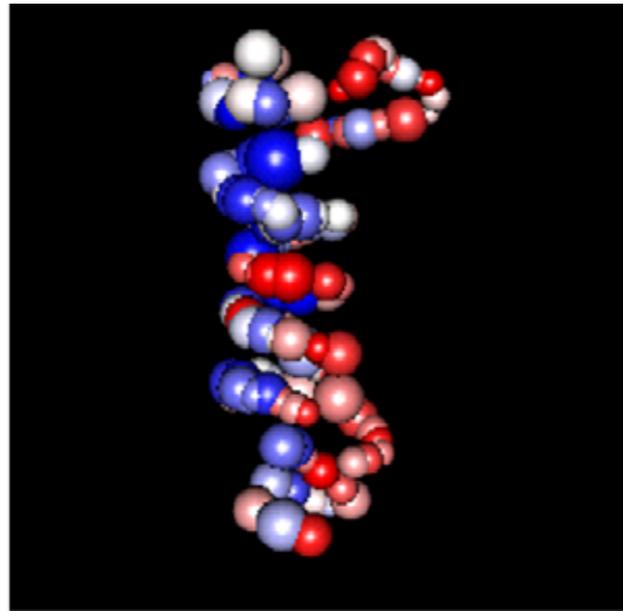
Bayesian Inference of Spatial Organizations of Chromosomes

Hu et al, (2013) PLoS computational biology

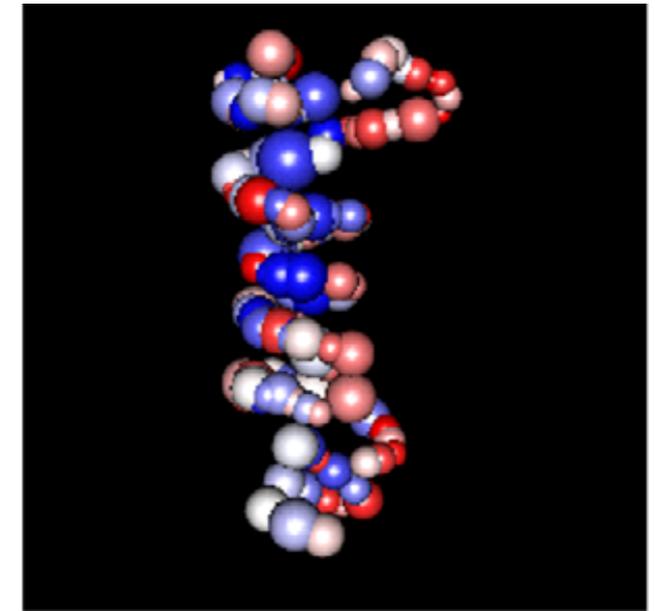
Compartment level



Gene density



Gene expression



Spatial organization of genomic and epigenetic features

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