
Identify chromatin interactions using ChIA-PET technology

Audrey Lapendry

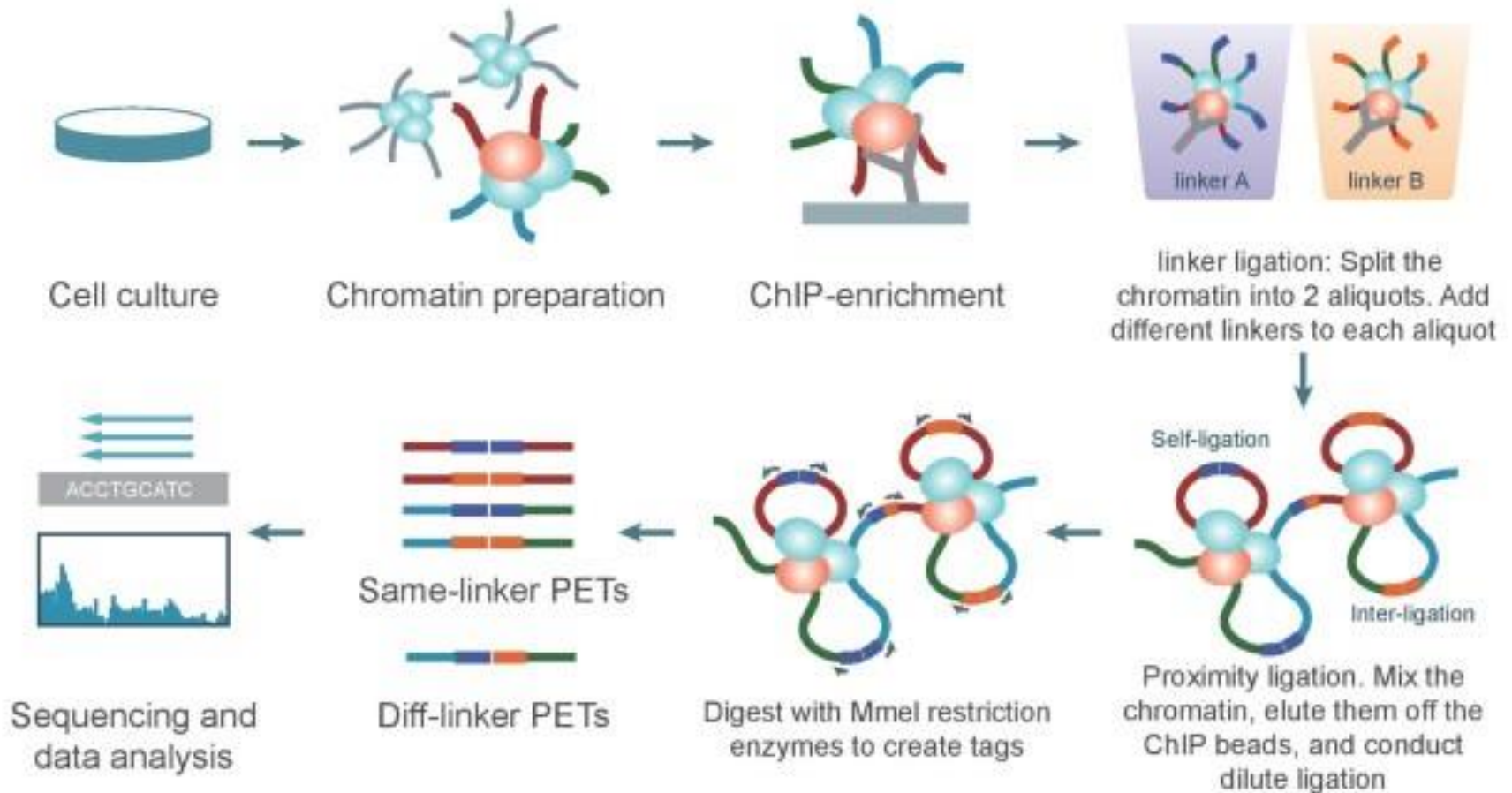
Club Bioinfo – 8/10/2020



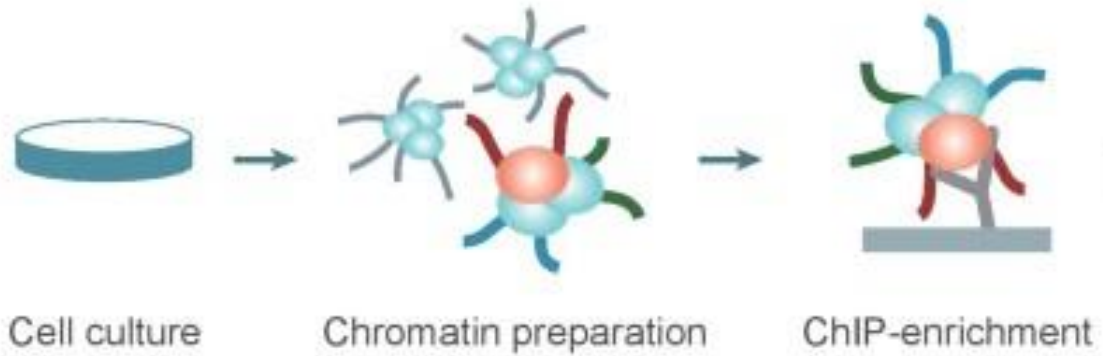
Introduction

- **ChIA-PET = Chromatin Interaction Analysis by Paired-End Tag sequencing**
- Fullwood MJ, Liu MH, Pan YF, Liu J, Xu H, Mohamed YB, Orlov YL, Velkov S, Ho A, Mei PH, et al. 2009. An oestrogen-receptor-alpha-bound human chromatin interactome. *Nature* 462:58–64.
- Identify: **interacting regions of chromatin & proteins binding sites**
- Applications:
 - Explore the **3D structure of chromatin**
 - Study **long-distance interactions** of chromatin → regulation of **gene expression**

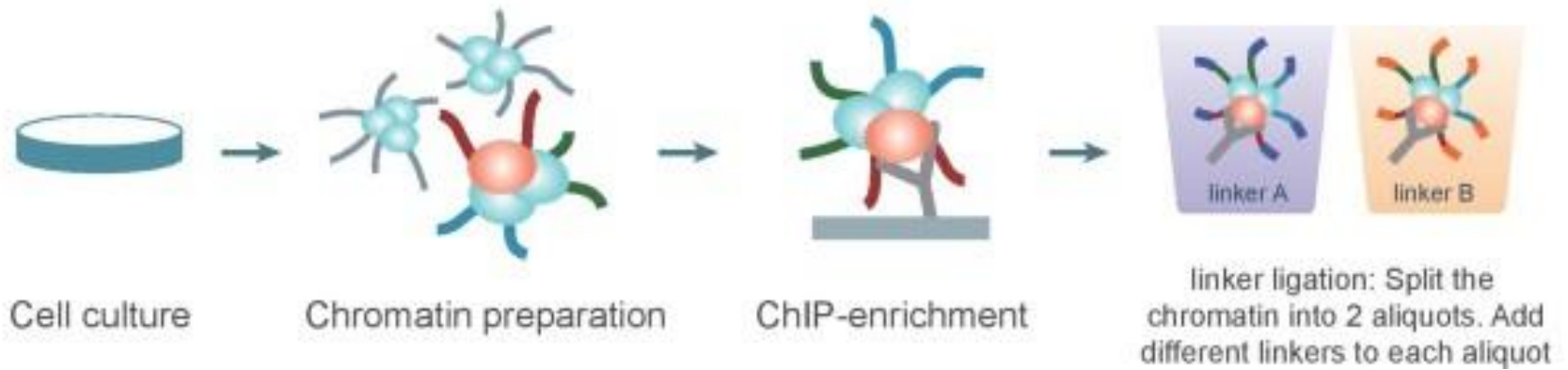
Experimental process



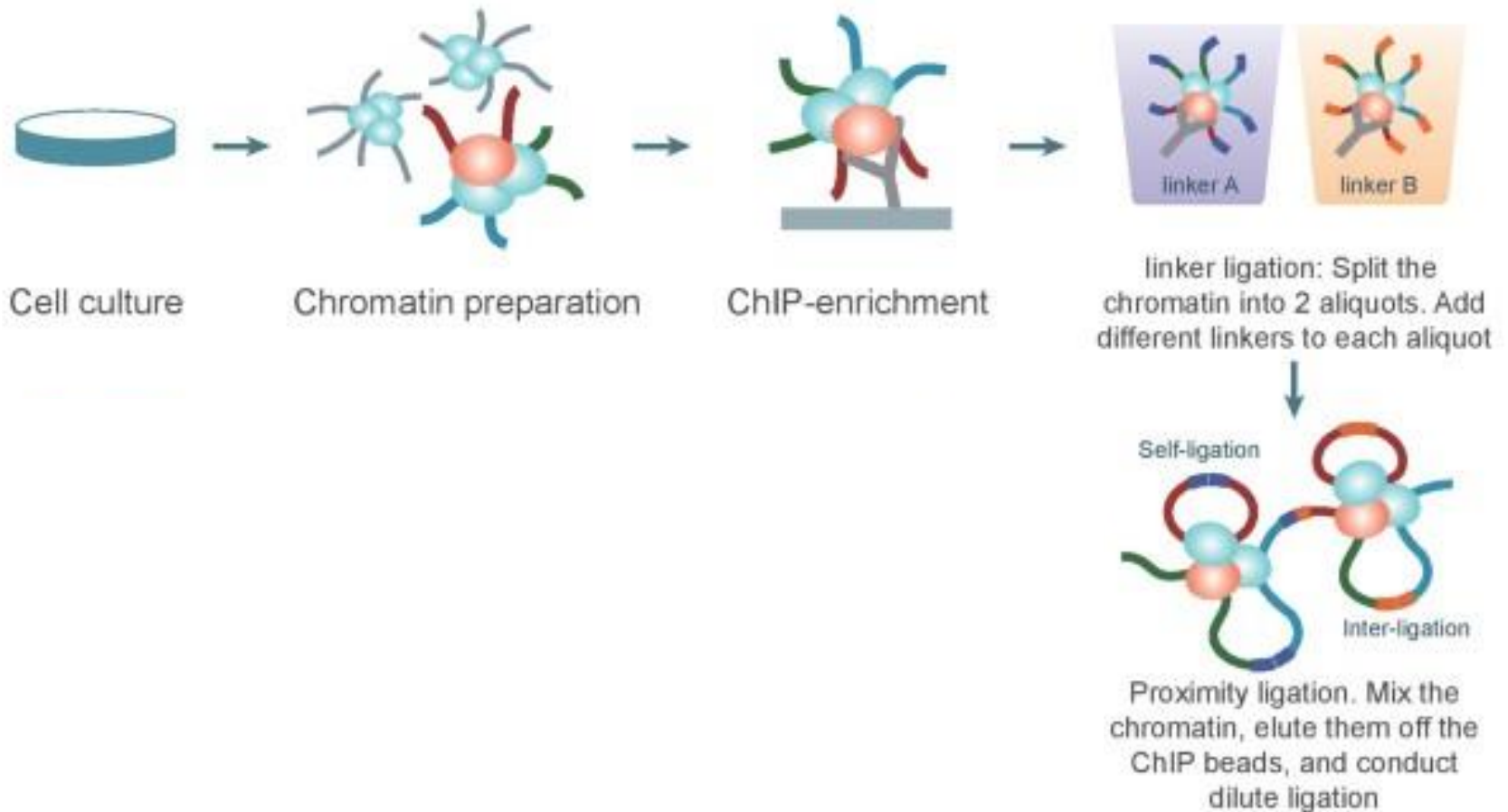
Experimental process



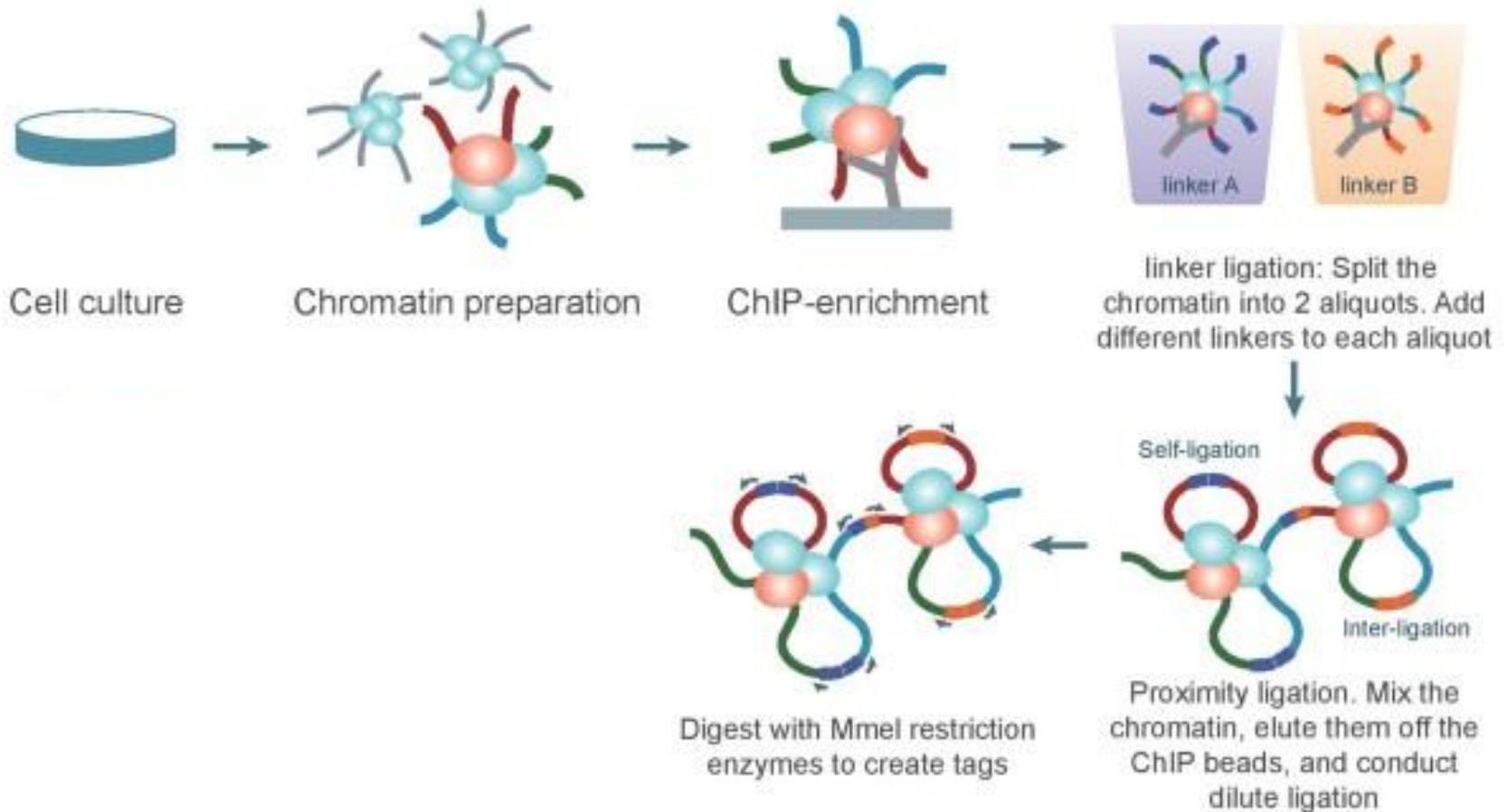
Experimental process



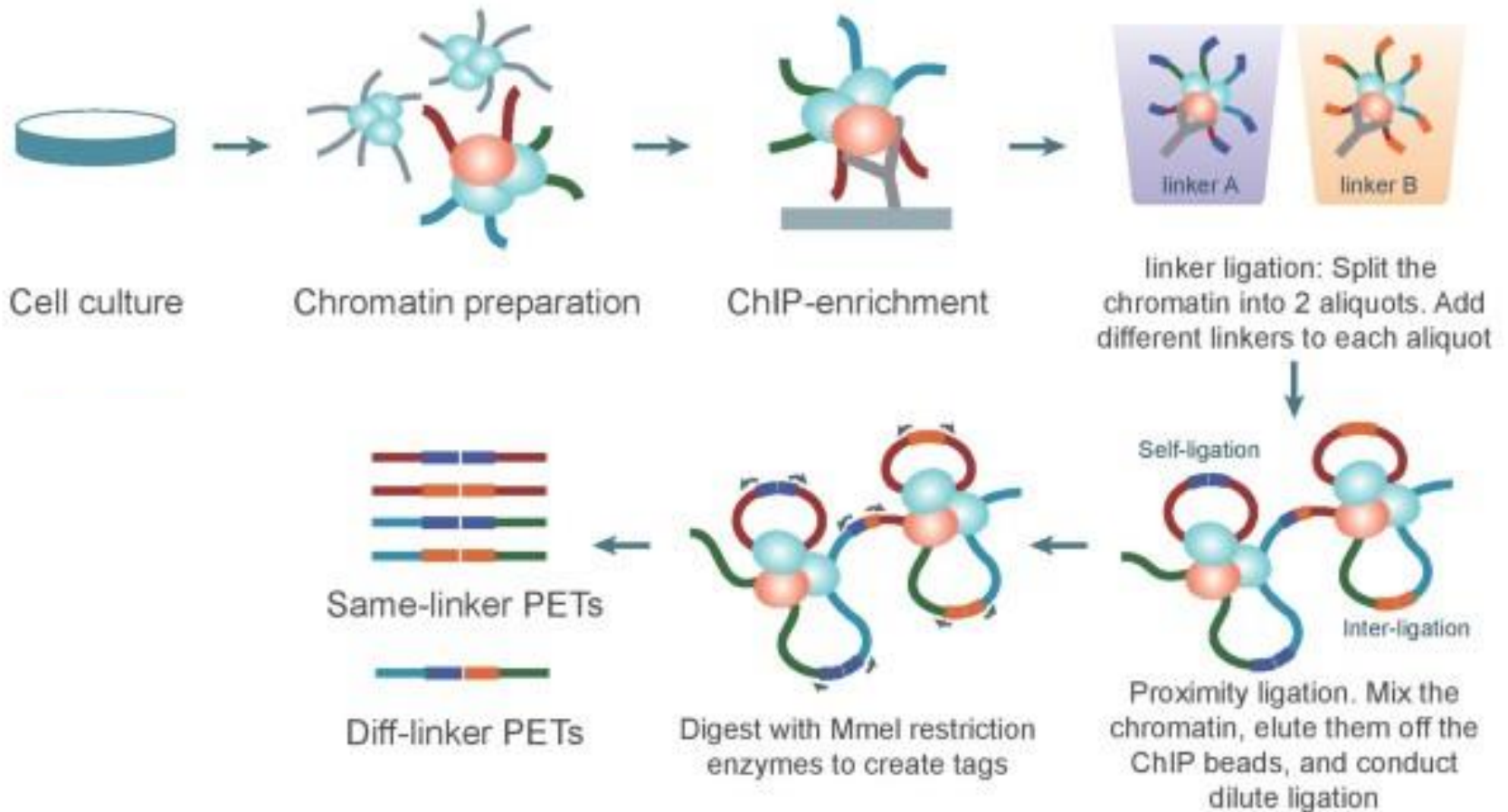
Experimental process



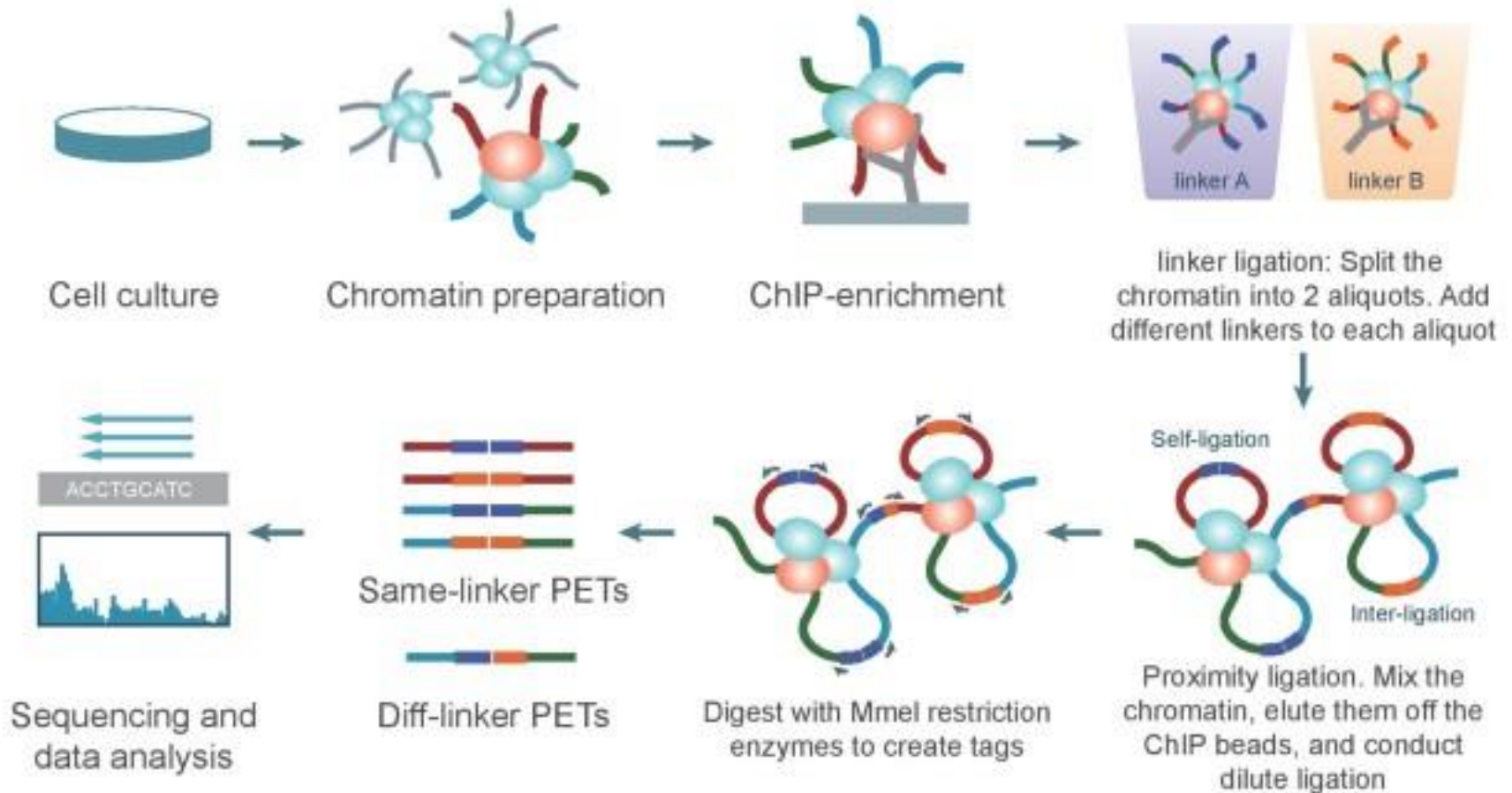
Experimental process



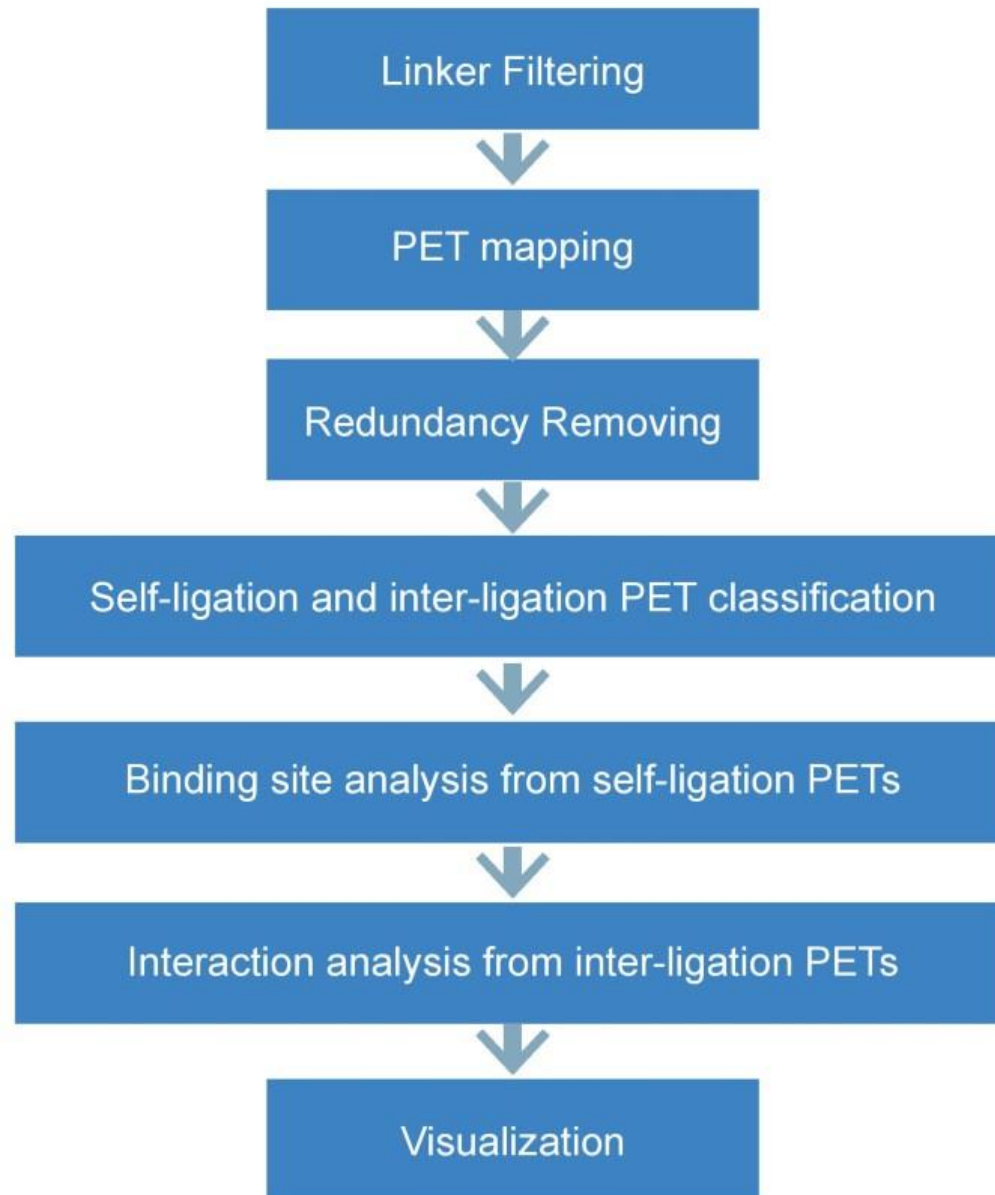
Experimental process



Experimental process



Data analysis



Data analysis

Linker Filtering

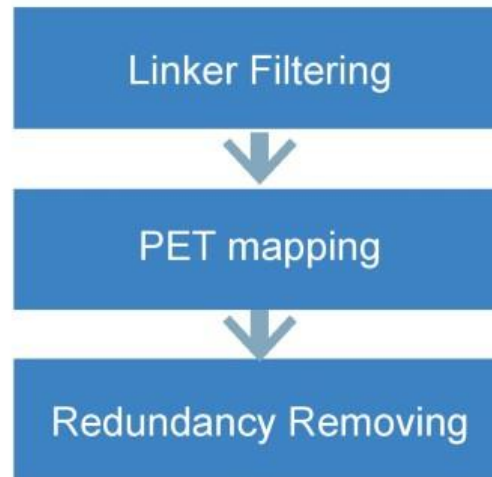
Data analysis

Linker Filtering

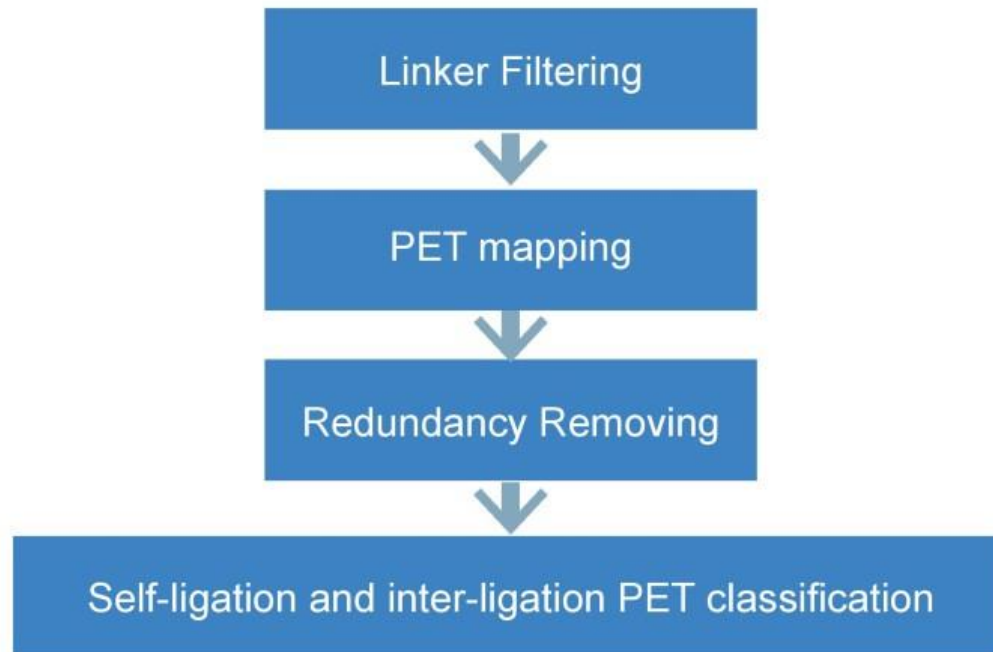


PET mapping

Data analysis

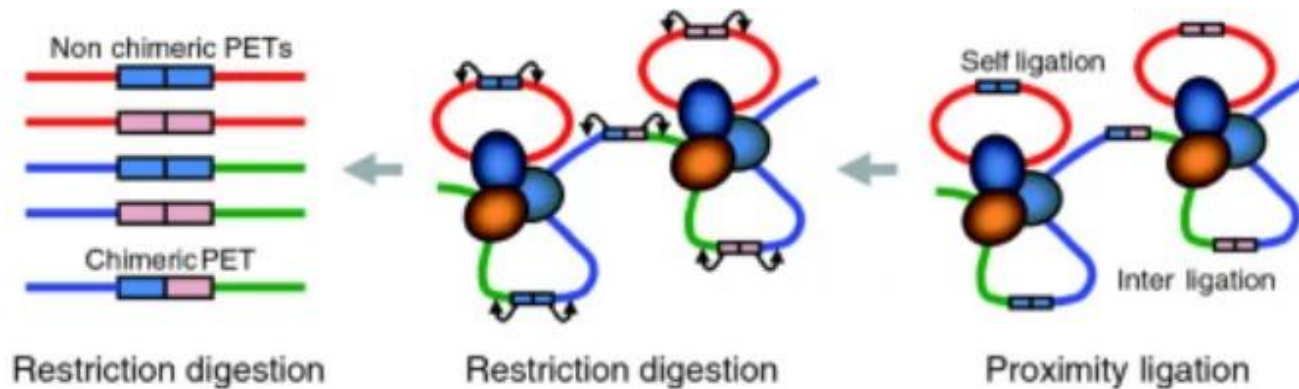


Data analysis



Data analysis – Self-ligation and inter-ligation PET classification

Self-ligation and inter-ligation PET classification

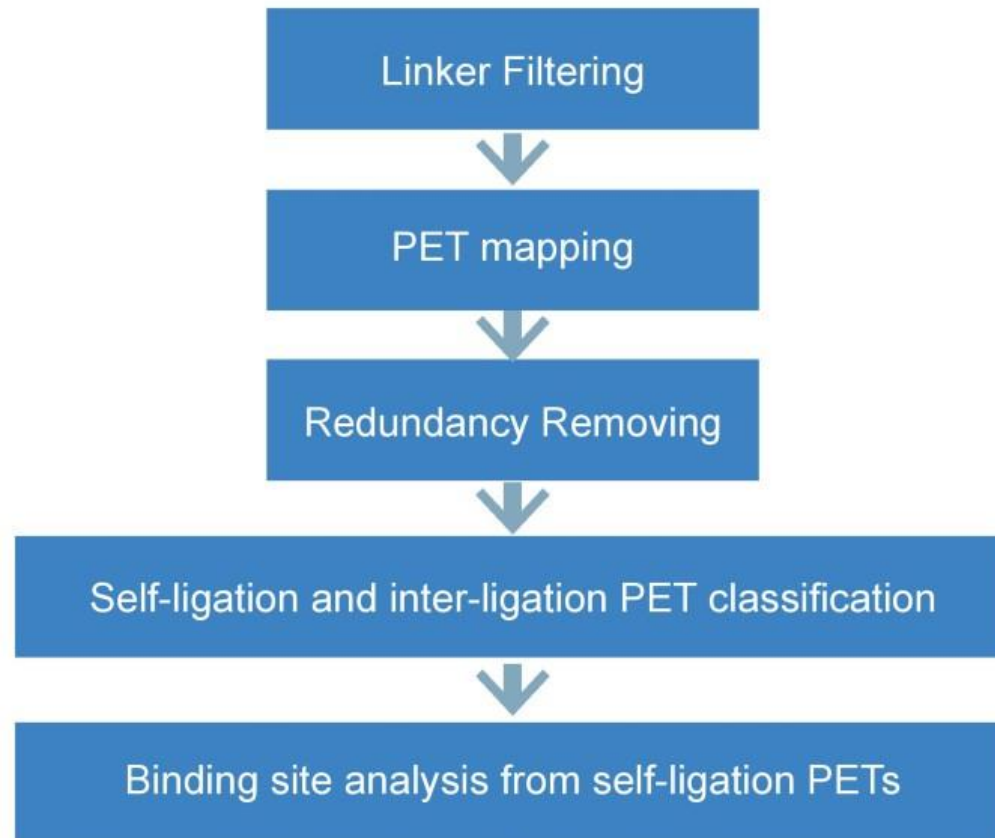


Self ligation PET
(One CHIP fragment)
< 4.6Kb

Inter ligation PET
(Two CHIP fragments)
> 4.6Kb

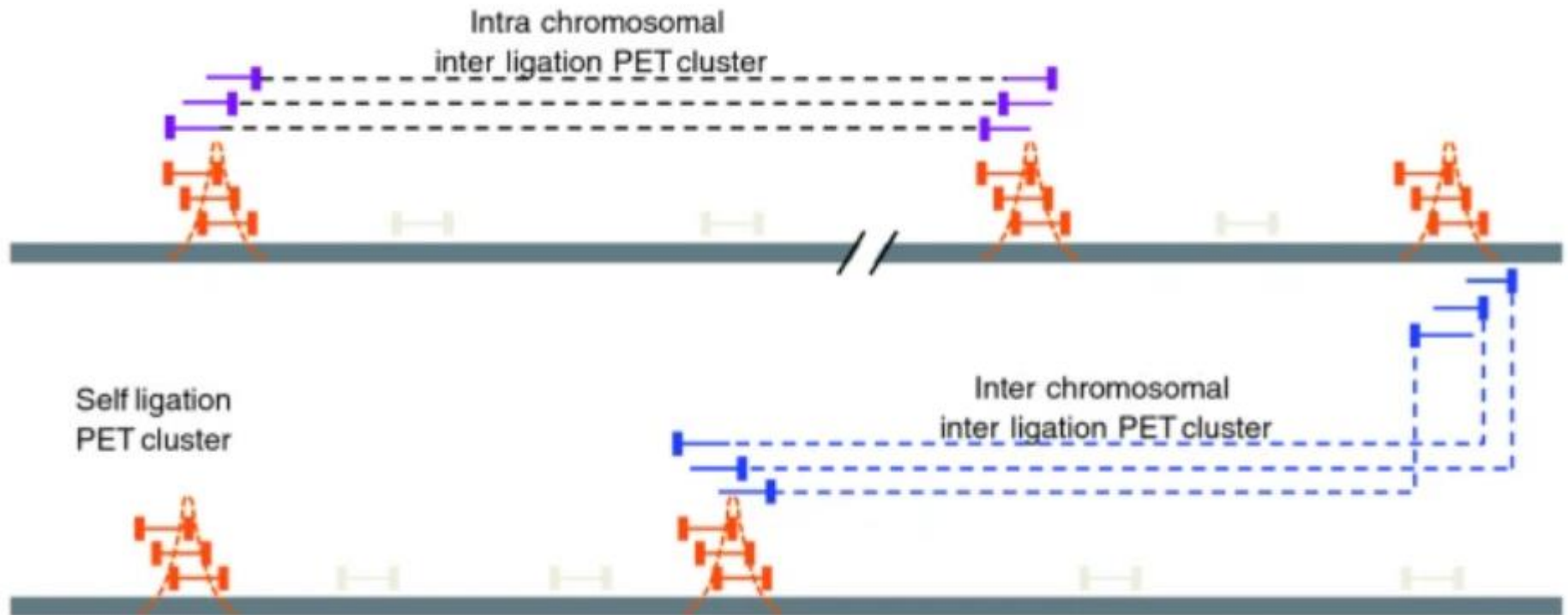


Data analysis

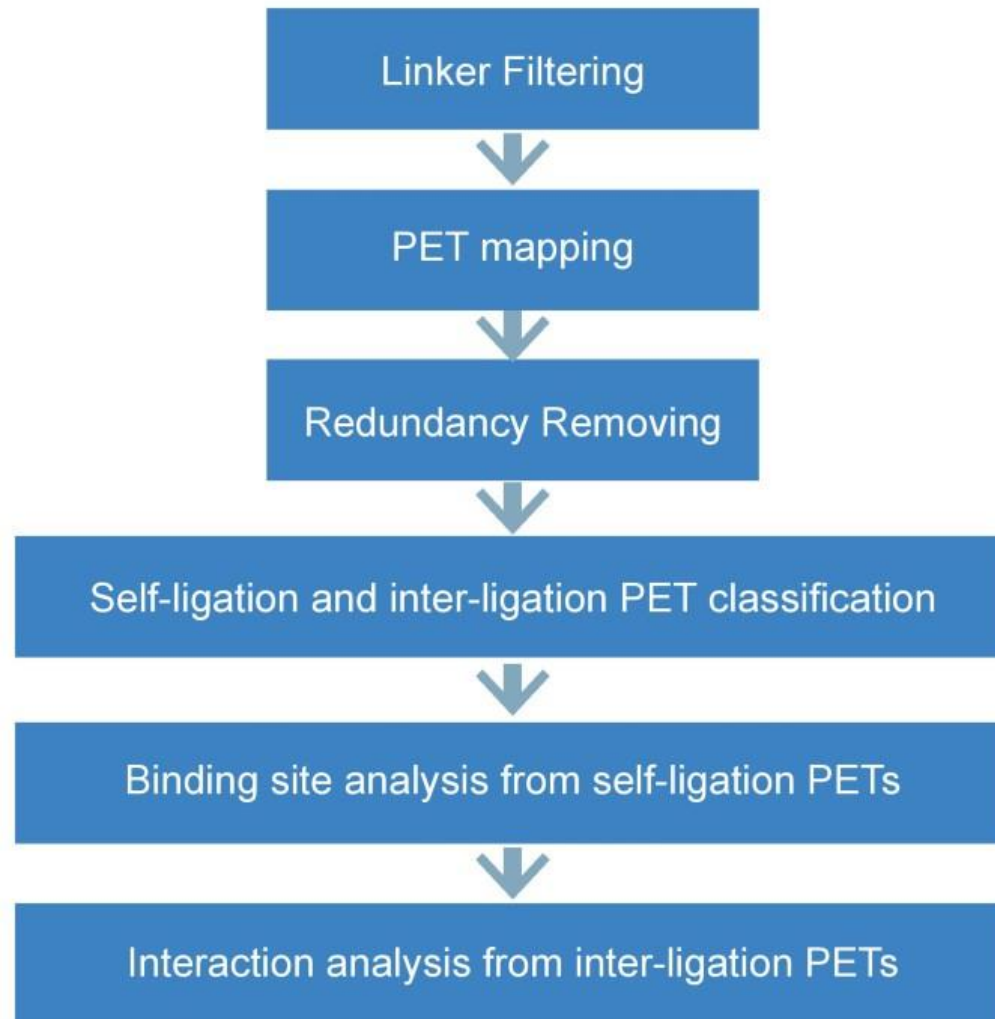


Data analysis – Binding site analysis from self-ligation PETs

Binding site analysis from self-ligation PETs

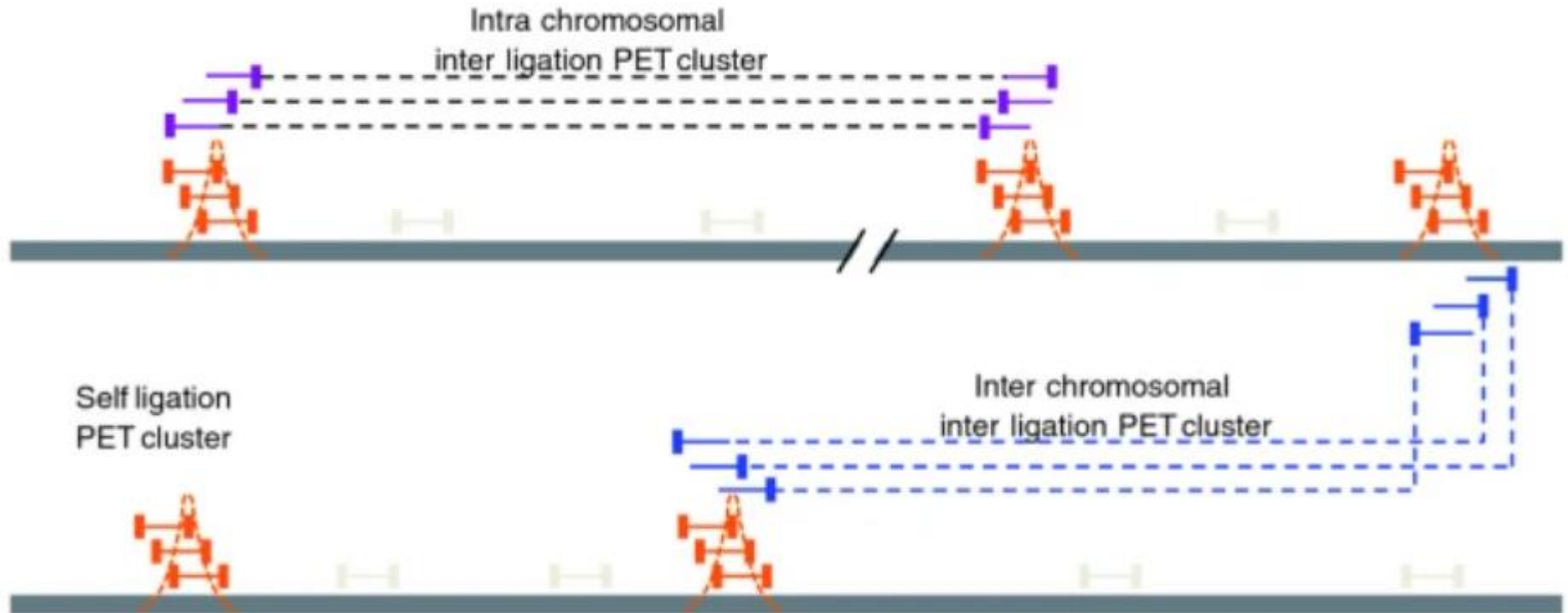


Data analysis

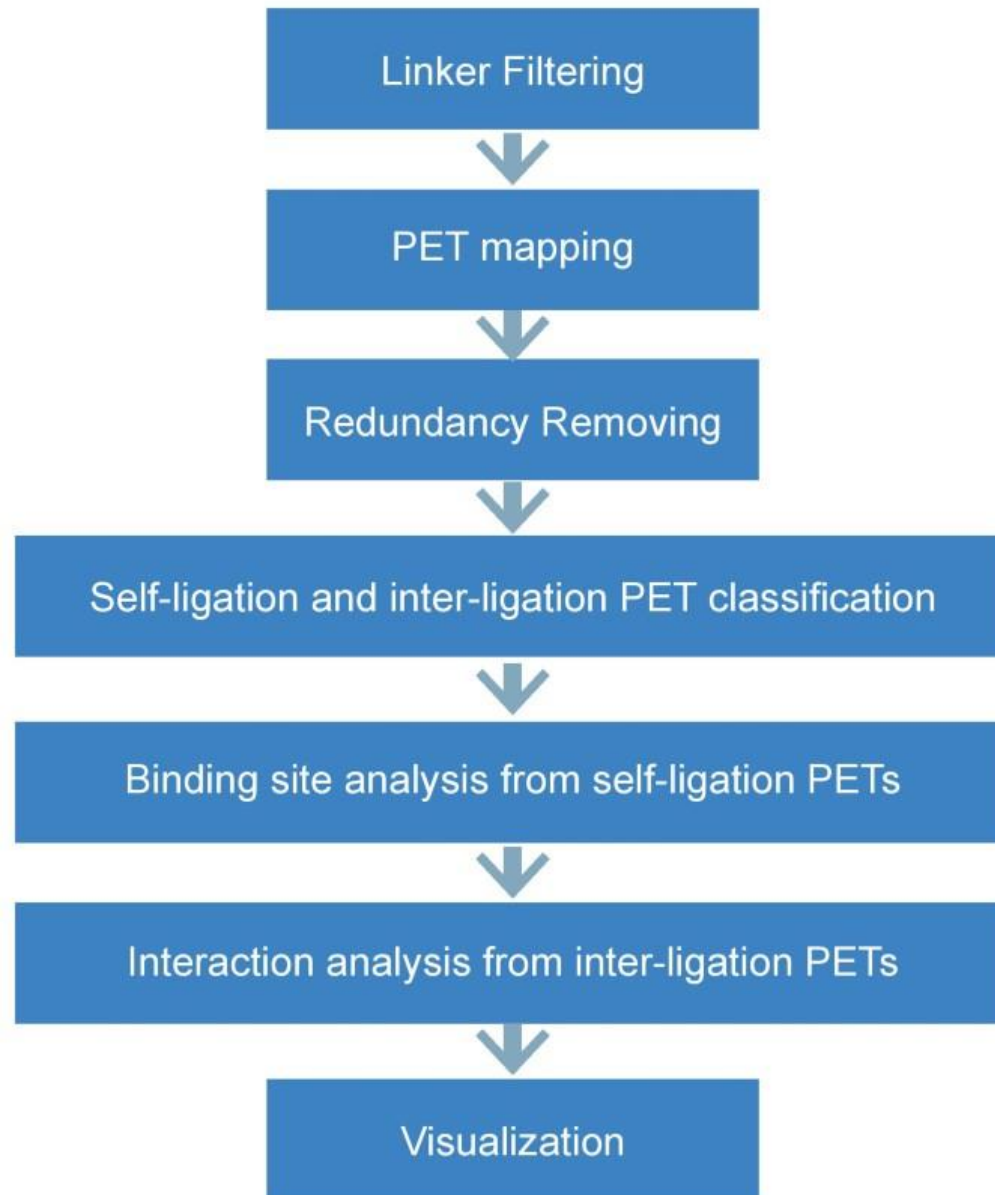


Data analysis – Interaction analysis from inter-ligation PETs

Interaction analysis from inter-ligation PETs

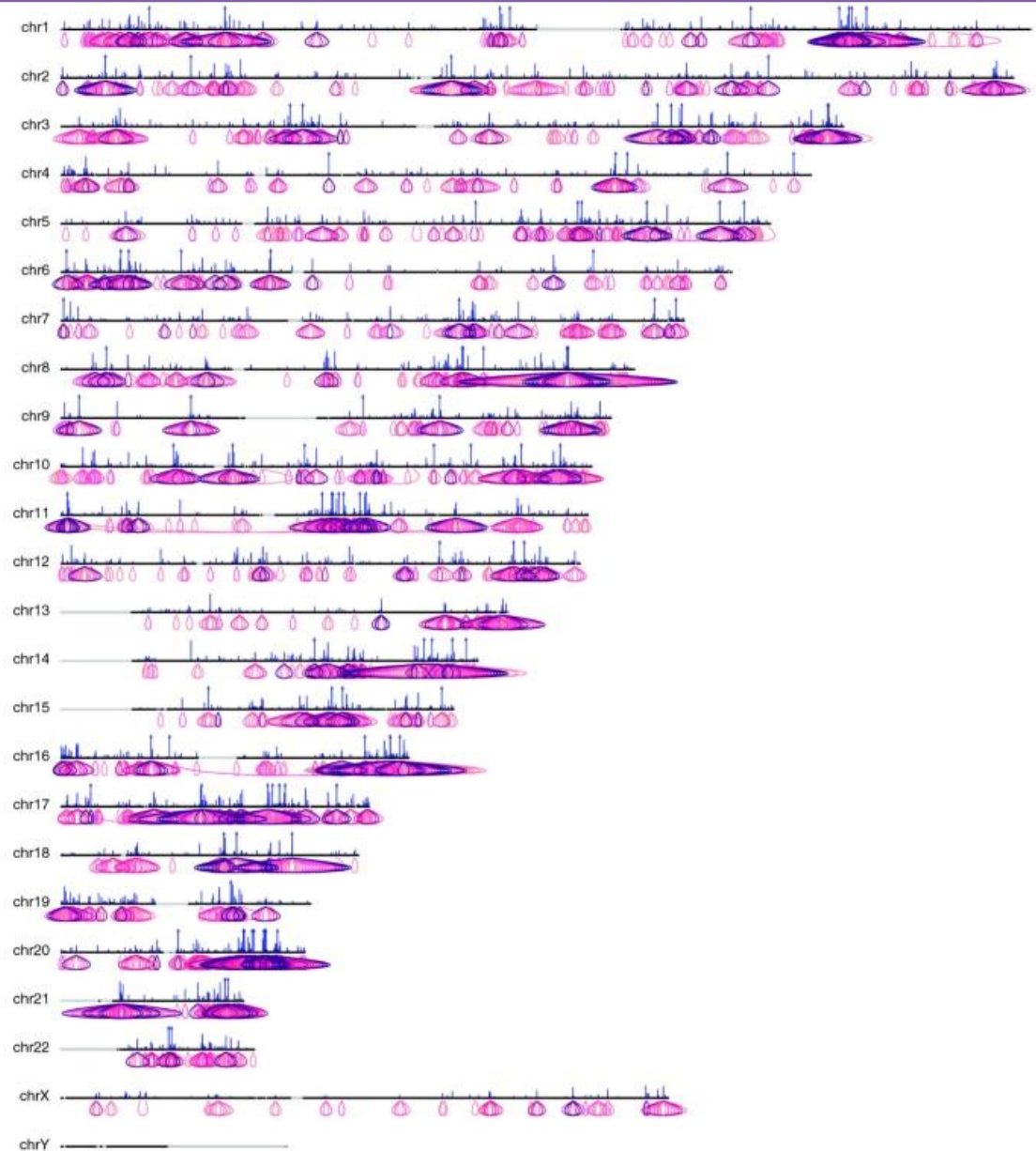


Data analysis



Data analysis – Visualization

Visualization



Tools available

- **ChIA-PET tool** (Li et al. 2010)

https://github.com/GuoliangLi-HZAU/ChIA-PET_Tool

- **Mango** (Phanstiell et al. 2015)

<https://github.com/dphansti/mango>

- **ChIA-PET2** (Li et al. 2017)

<https://github.com/GuipengLi/ChIA-PET2>

- **ChIAPoP** (Huang et al. 2019)

<https://github.com/wh90999/ChIAPoP>

- **ChIA-PIPE** (Lee et al. 2020)

<https://github.com/TheJacksonLaboratory/ChIA-PIPE>

Conclusion

- **High resolution** to study chromatin interactions
- **ChIP:**
 - **Reduce the complexity** of a genome-wide analysis
- **limit to chromatin interactions linked to a specific factors of interest**
- **Limited sensitivity**, only detects part of interactions
- **Few interactions** identified by ChIA-PET **validated experimentally**

Bibliography

First paper:

- Fullwood MJ, Liu MH, Pan YF, Liu J, Xu H, Mohamed YB, Orlov YL, Velkov S, Ho A, Mei PH, et al. 2009. An oestrogen-receptor-alpha-bound human chromatin interactome. *Nature* 462:58–64.

Applications:

- Li G, Cai L, Chang H, Hong P, Zhou Q, Kulakova EV, Kolchanov NA, Ruan Y. 2014. Chromatin Interaction Analysis with Paired-End Tag (ChIA-PET) sequencing technology and application. *BMC Genomics* [Internet] 15. Available from: <https://bmcgenomics.biomedcentral.com/articles/10.1186/1471-2164-15-S12-S11>

Experimental protocols:

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- Li X, Luo OJ, Wang P, Zheng M, Wang D, Piecuch E, Zhu JJ, Tian SZ, Tang Z, Li G, et al. 2017. Long-read ChIA-PET for base-pair-resolution mapping of haplotype-specific chromatin interactions. *Nat. Protoc.* 12:899–915.

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Tools:

- Li G, Fullwood MJ, Xu H, Mulawadi FH, Velkov S, Vega V, Ariyaratne PN, Mohamed YB, Ooi H-S, Tennakoon C, et al. 2010. ChIA-PET tool for comprehensive chromatin interaction analysis with paired-end tag sequencing. *Genome Biol.* 11:R22.
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- Lee B, Wang J, Cai L, Kim M, Namburi S, Tjong H, Feng Y, Wang P, Tang Z, Abbas A, et al. 2020. ChIA-PIPE: A fully automated pipeline for comprehensive ChIA-PET data analysis and visualization. *Sci. Adv.* 6:eaay2078.