DNA-based hydrogels as tunable scaffolds for cell mechanobiology

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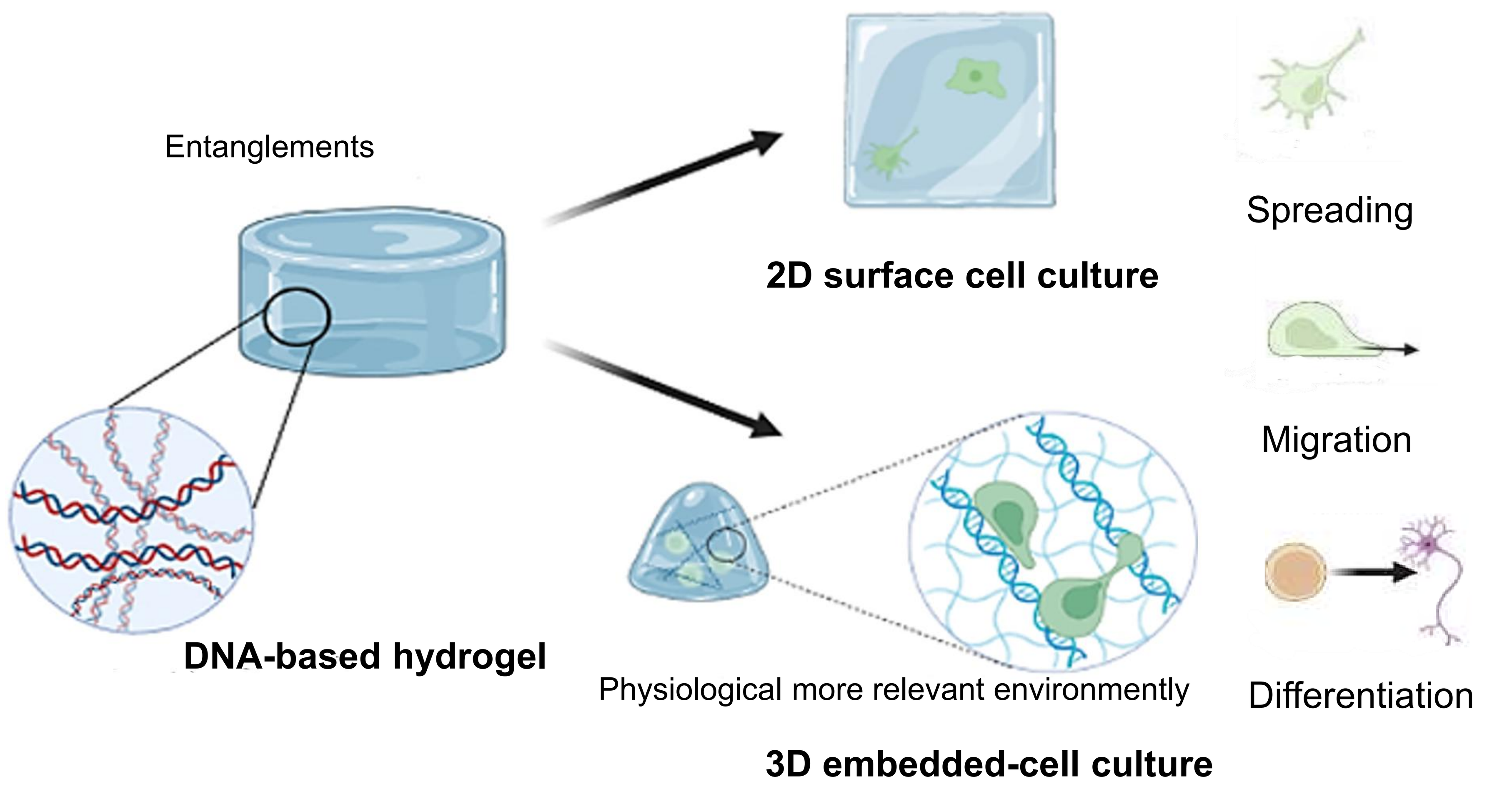
Introduction

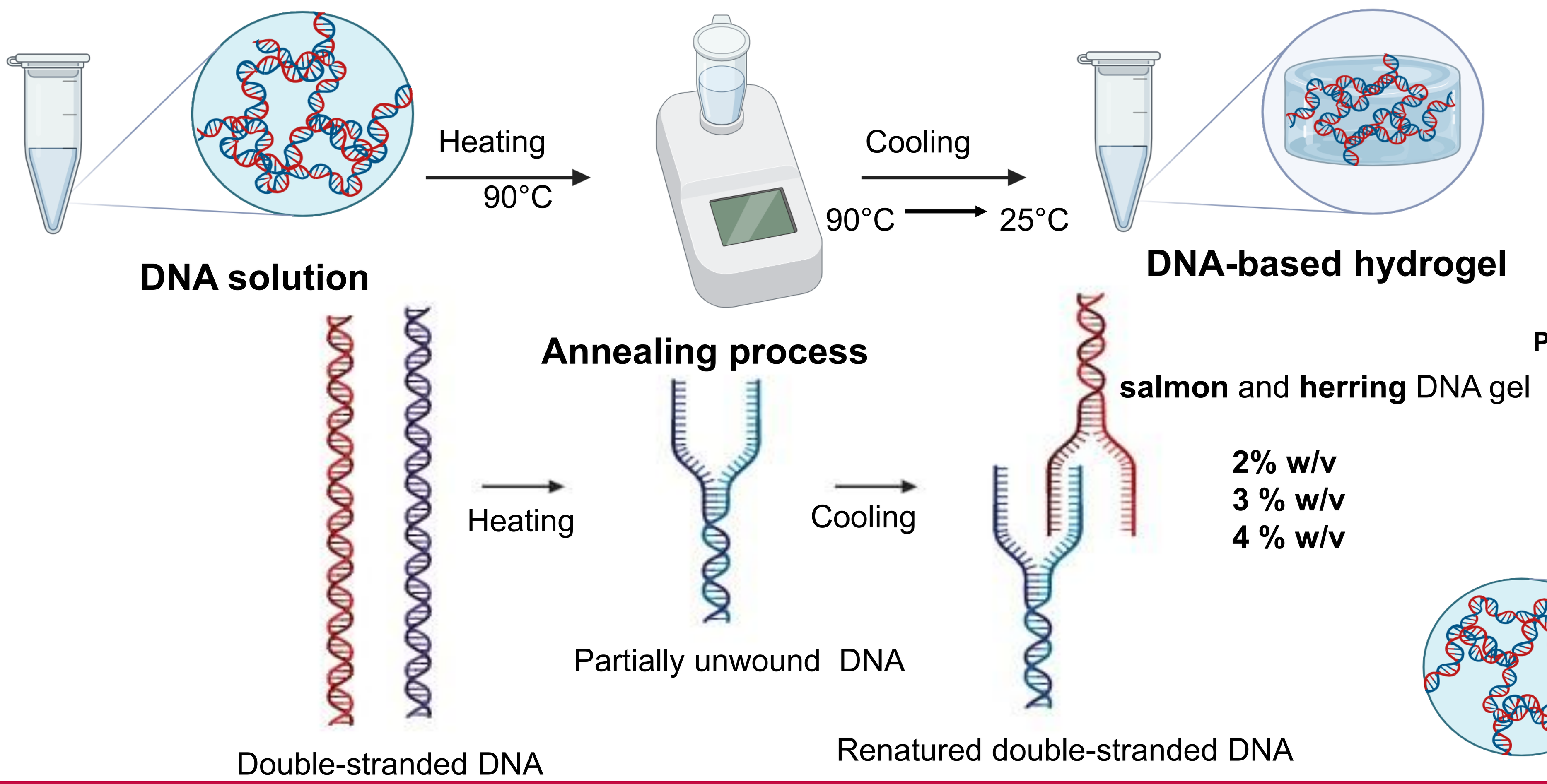
It has been demonstrated several times that the microcellular environment directly influences many biological processes. Consequently, accurately reproducing this environment is essential not only for a better understanding of diseases progression, but also for developing innovative bioengineering approaches. Hydrogels have emerged as promising biomaterials due to their ability to closely replicate natural tissue environments [1]. Among them, DNA-based hydrogels have attracted considerable attention because of the intrinsic properties of DNA such as :

- Biocompatibility
- Programmability
- Adaptable mechanical properties [2]

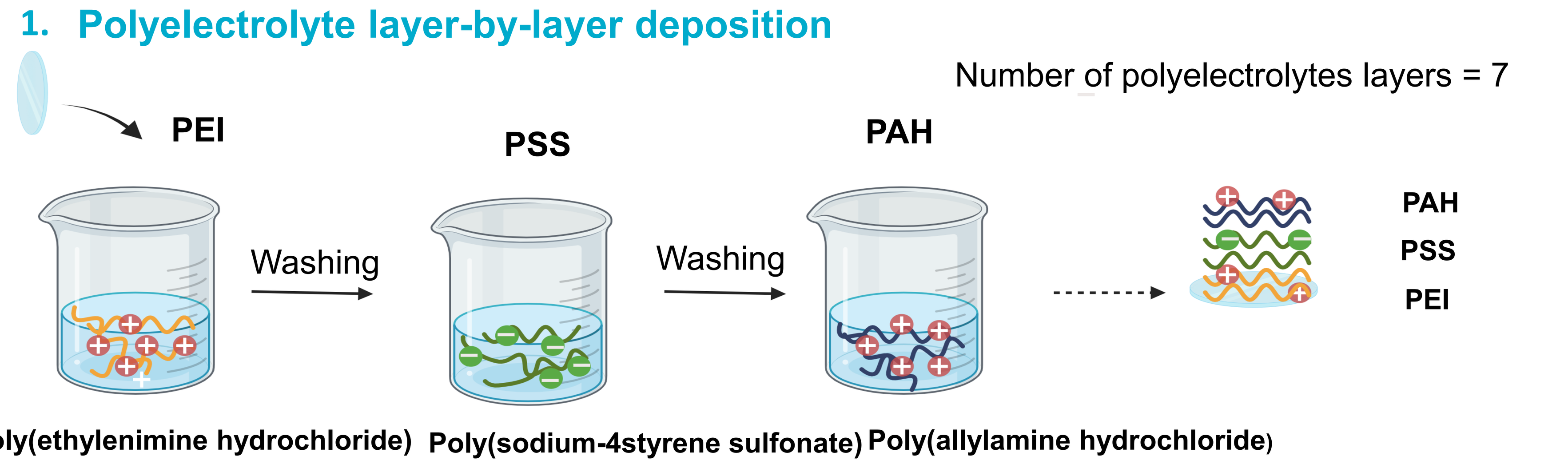
In this poster, we have used genomic DNA to create innovative modulable scaffolds for 2D and 3D cell culture. We have studied the chiroptical properties of genomic DNA in aqueous solutions, gel state and investigated the stiffness by nanoindentation technique.



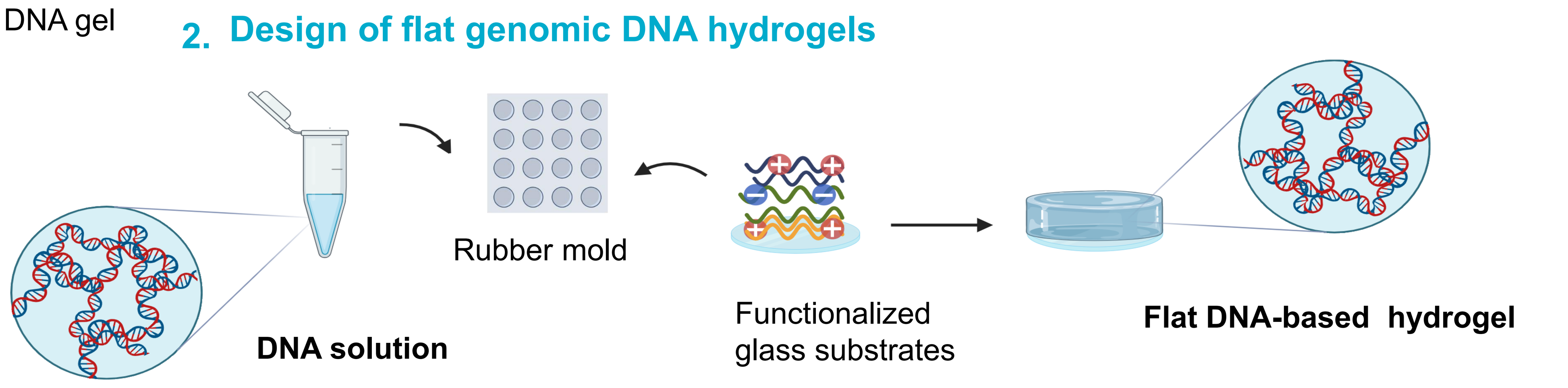
Strategy: design of genomic DNA hydrogels



1. Polyelectrolyte layer-by-layer deposition



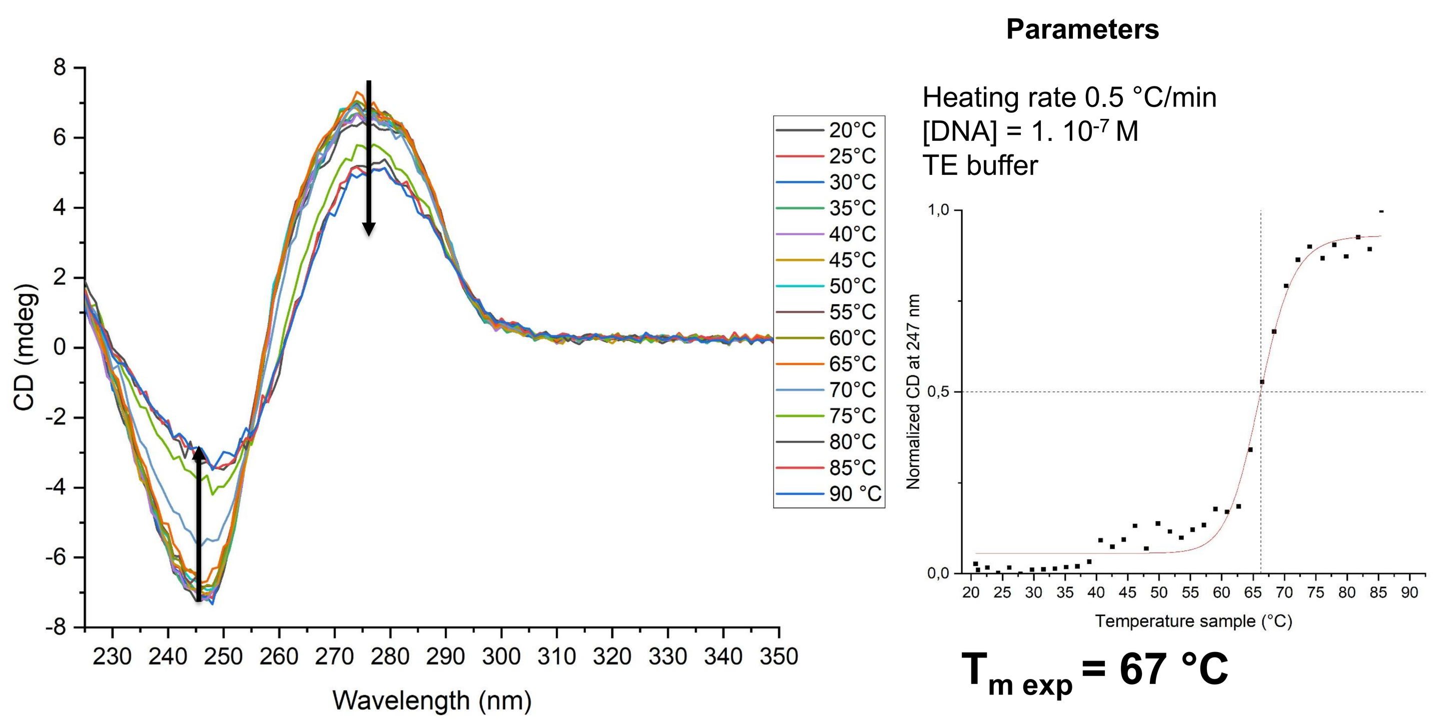
2. Design of flat genomic DNA hydrogels



Preliminary results: chiroptical properties and mechanical analysis

1. Chiroptical properties of genomic DNA in aqueous solution

CD temperature-ramping experiments for salmon DNA

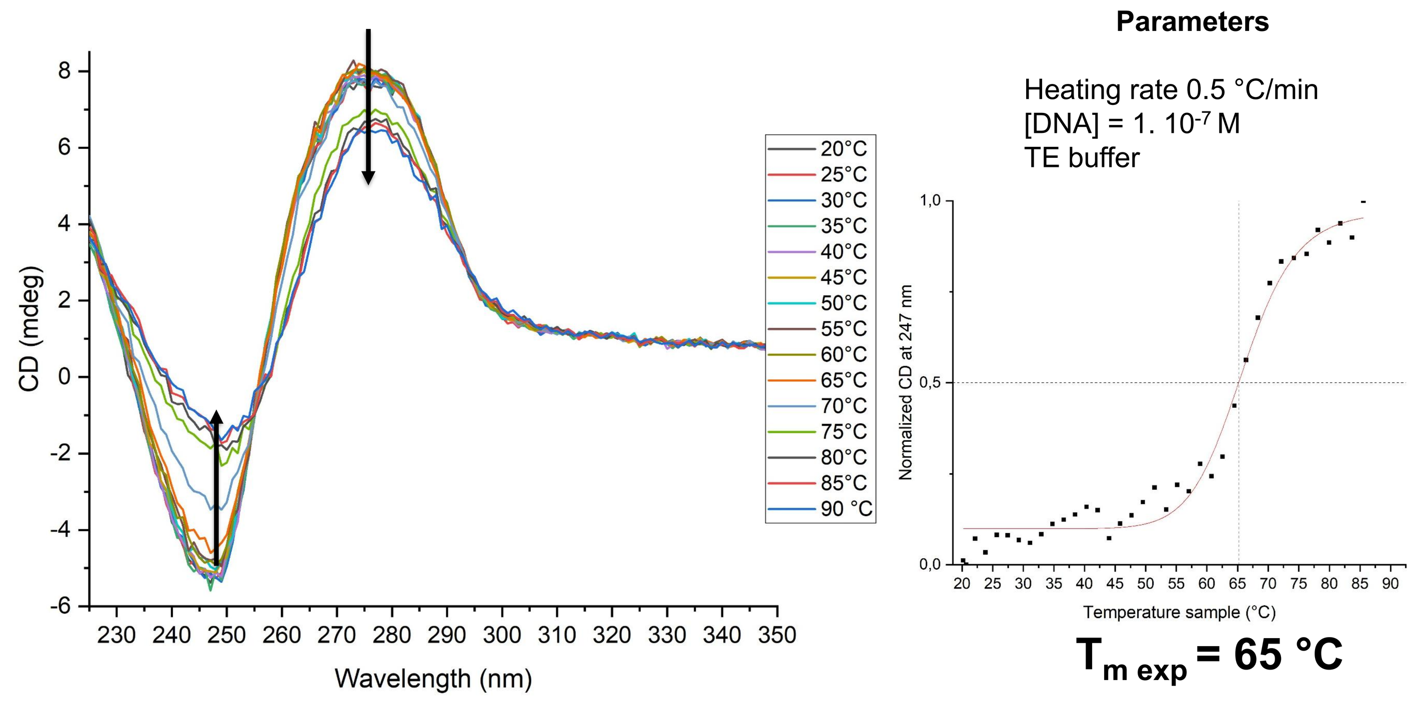


$T_{m\ exp}$ = 67 °C

Figure 1 : CD temperature-ramping experiments for salmon DNA in aqueous solution

- CD signal of DNA decreases when temperature increases
- Double-strand DNA → Single-strand DNA **Reduction of excitonic coupling**
- Sigmoidal curves → cooperative effect

CD temperature-ramping experiments for herring DNA



$T_{m\ exp}$ = 65 °C

Figure 2 : CD temperature-ramping experiments for herring DNA in aqueous solution

2. Chiroptical properties of genomic DNA in gel state

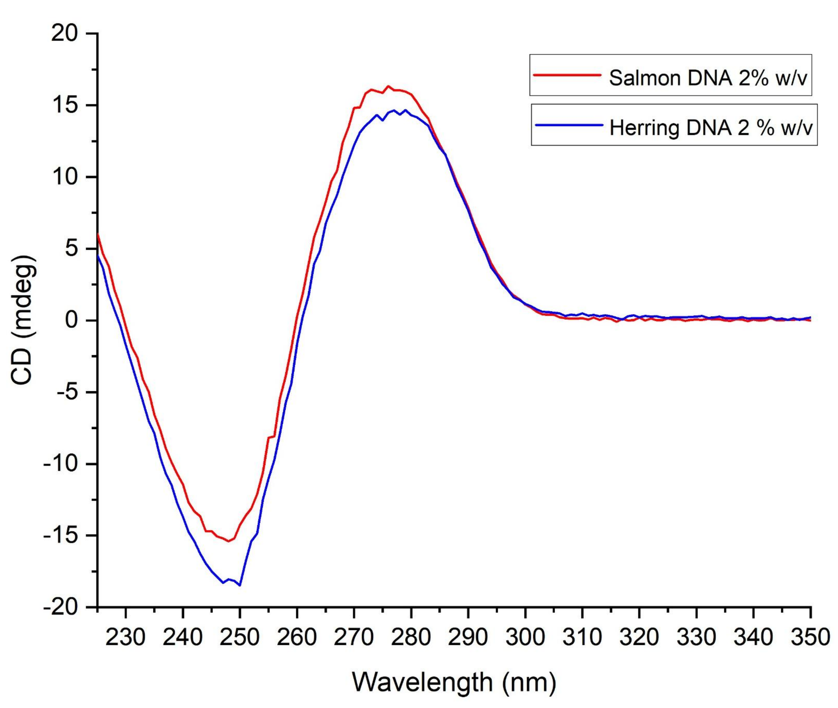


Figure 3 : CD spectra of salmon and herring DNA in gel state.

- CD spectra of genomic DNA are similar in solution and in gel state

→ hydrogels are composed mainly of large portions double-stranded DNA

3. Local mechanical properties of DNA hydrogels

Salmon DNA hydrogels

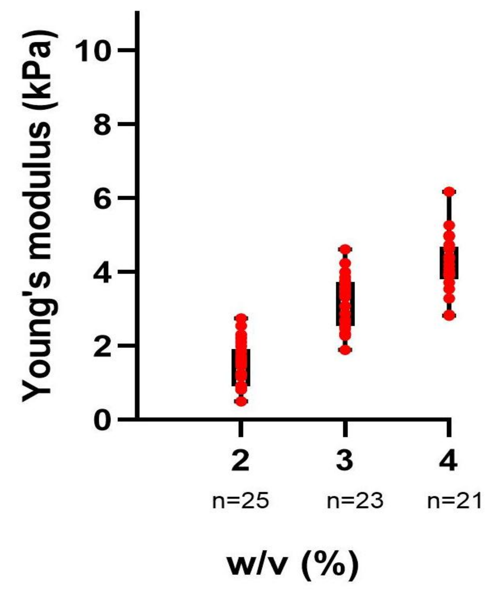
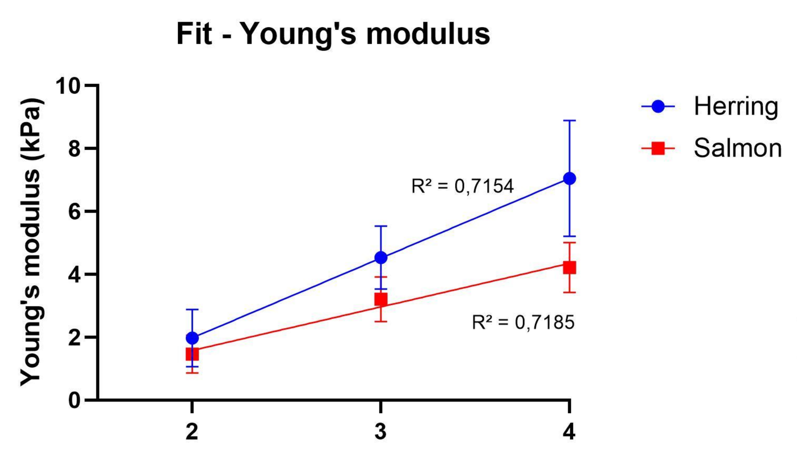


Figure 4 : Young's modulus analysis of salmon DNA hydrogels at different concentrations

- The stiffness of the gels is in the kPa range, and that varying the DNA concentration allows us to modulate E from 1 kPa to 8 kPa
- Young's modulus measurements show high reproducibility



Herring DNA hydrogels

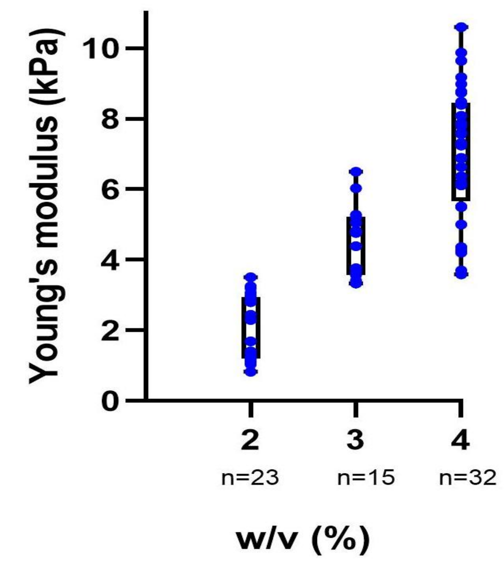


Figure 5 : Young's modulus analysis of herring DNA hydrogels at different concentrations

Conclusion and outlook

- These preliminary results highlight the potential of these DNA-based hydrogels as a modular platform for studying and understanding the influence of mechanical properties on cell behavior.
- A morphological analysis of DNA-based hydrogels should be performed in the future.

References

1. U. Blache, E. M. Ford, B. Ha, L. Rijns, O. Chaudhuri, P.Y.W Dankers, A. P. Kloxin, J. G. Snedeker and E. Gentleman, *Nat Rev Methods Primers 2*, **2022**, 98.
2. J. Gačanin, C. V. Synatschke and T. Weil, *Adv Funct Materials*, **2020**, 30, 1906253.

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