From measurement to decision: a tissue-aware digital-twin platform for CAR T cell dosimetry

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Together we are beating cancer

Problem & Gap

Agent-based models (ABM), are powerful scaffolds for personalised medicine. As **digital twins**, they let us:

- Trial dosimetry strategies
- Generate and test wet-lab hypotheses
- Reduce exploratory animal use

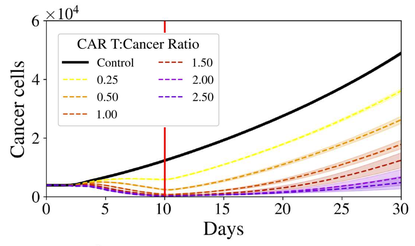
But ABM only become **robust enough to guide treatment dose, timing and route** when calibrated and validated using **tissue-resolved measurements**. Those measurements remain **scarce and fragmented**, leaving many existing models **illustrative rather than actionable**.

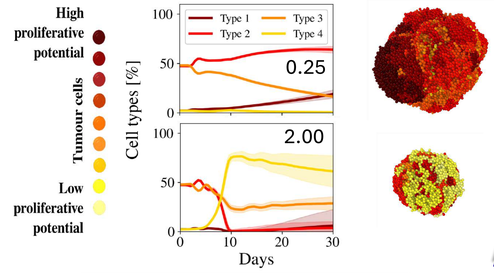
What we are doing

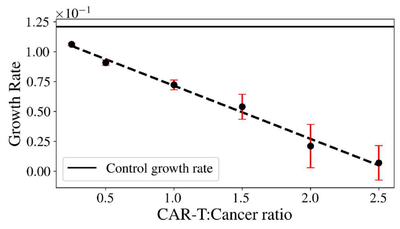
- We're building a **hybrid lab** that integrates **dry lab, wet lab, and software/data delivery.** We generate the **tissue-resolved measurements** (time points, spatial distributions, biomechanics) needed to **calibrate and validate** our CAR T digital twin, and we curate **standardised, shareable datasets** for the community.
- In parallel, we run our ABM as the **BioDynaMo** engine on **HPC** with a **user-friendly UI**, so non-coders can test treatment **dose, fractionation, and route** rapidly.
- The outcome is a **tissue-aware digital-twin loop—**fast, interpretable, and designed to **reach patients.**

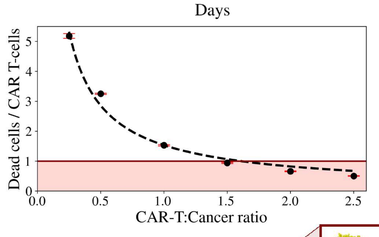
Agent-Based Model: CAR T cell digital twin

One Dose: increasing cellular dosage does not always increase efficacy

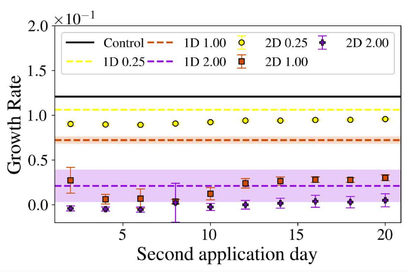


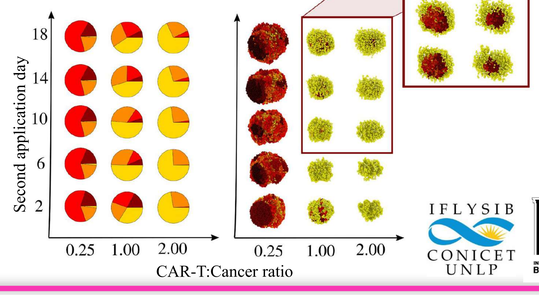


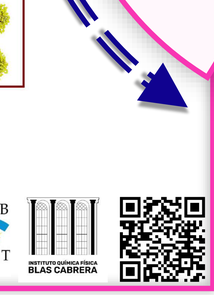




Multiple dosing to prevent CAR T cells hypofunction

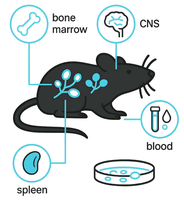






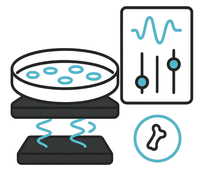
Wet-Lab: CAR T cell functioning and persistence

We will quantify CAR T functionality and persistence across tissues and different dosimetry strategies, using multimodal assays in B cell Acute Lymphoblastic Leukaemia models



Organ-to-organ Atlas of CAR T cells function

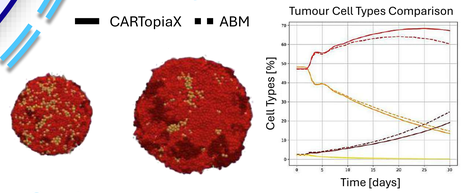
Dosimetry Strategy



Biomechanics

CARTopiaX: BioDynaMo implementation

Our ABM powers BioDynaMo, an open-source platform for creating, running, and visualising 3D agent-based simulations, delivering HPC-class performance, modular reproducibility, and an accessible interface.



CARTopiaX reproduces the tumour growth and CAR T cell therapy administration of our ABM.

2x faster, even pre-optimisation. Preliminary benchmark (Ryzen 5 3600, 6C/12T, 16 GB): **CARTopiaX 8,9 h** vs **ABM 18,8 h.**

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