Biomaterials for MX

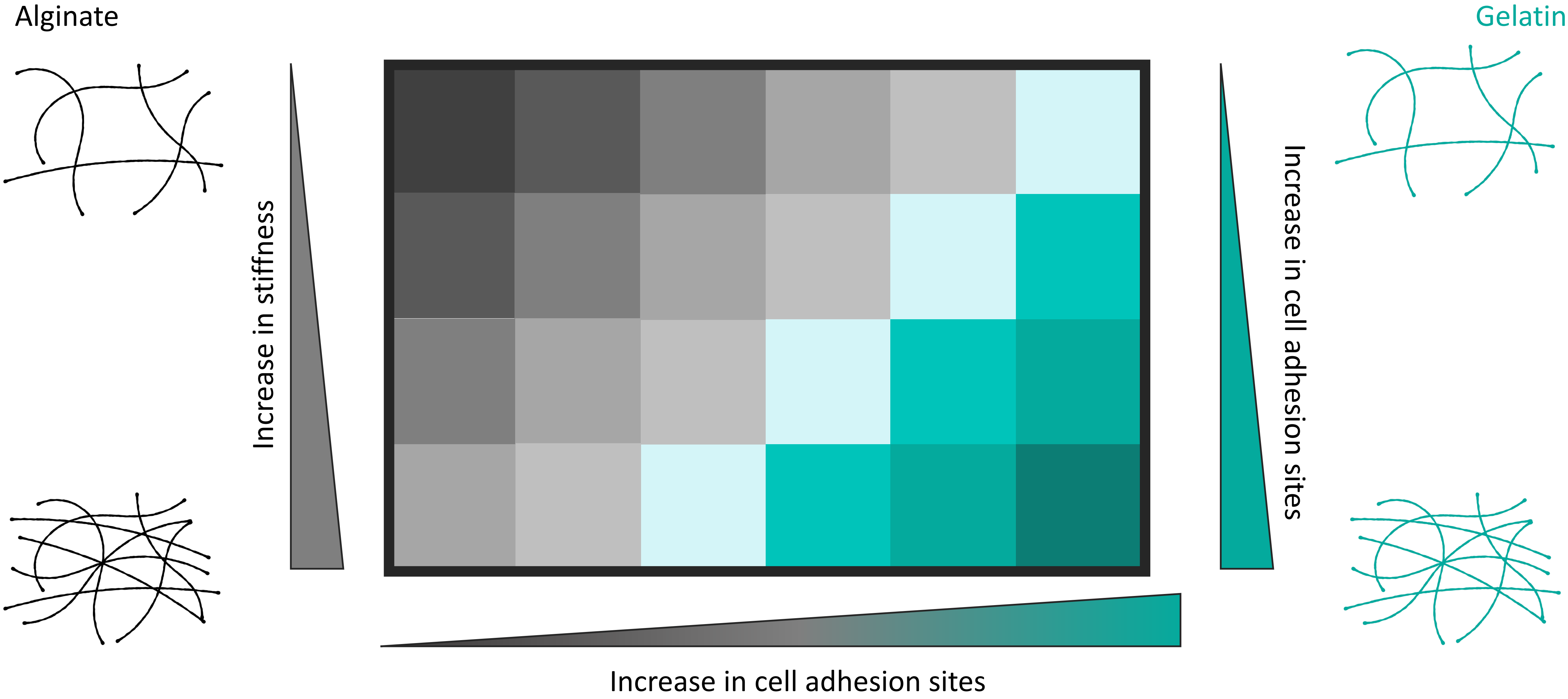
MSE – 471 (2024)

Prof. Maartje M.C. Bastings

Experimental Sessions at DLL

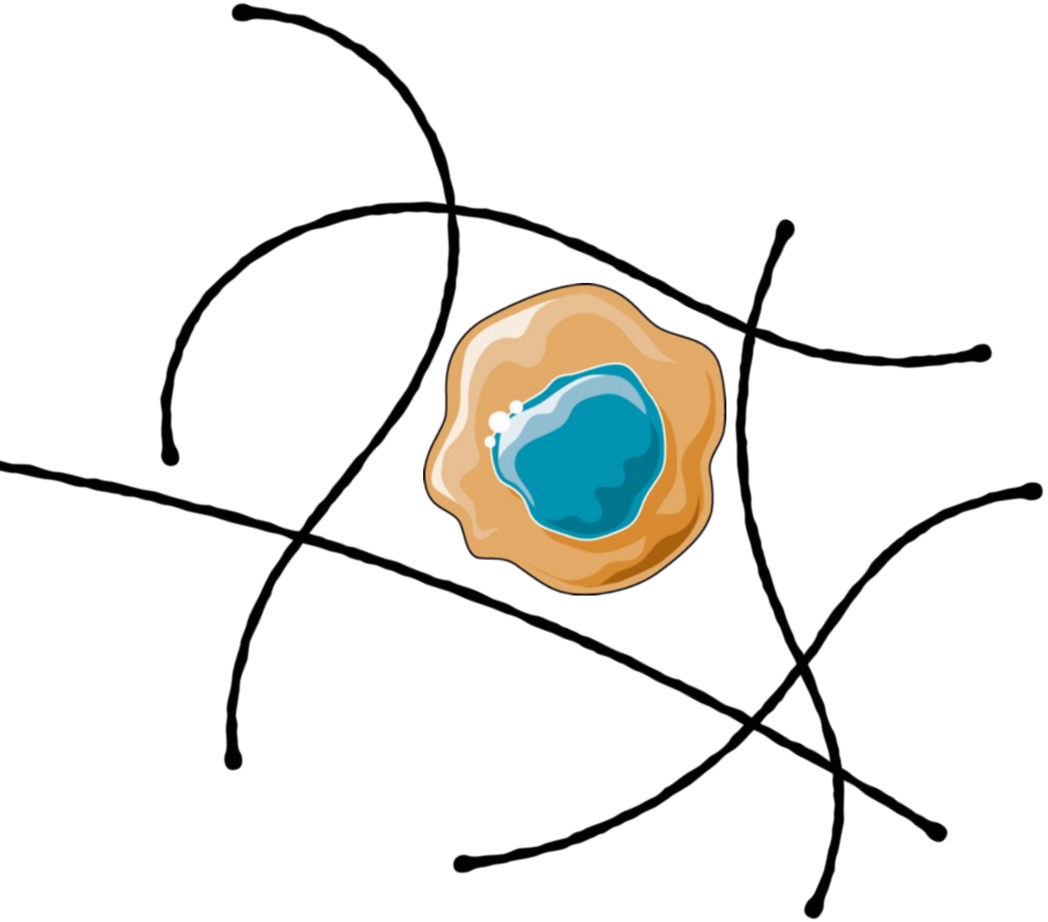
BLOCK 1: Stiffness of Scaffolds

How to control mechanical properties and chemical identity of biomaterial scaffolds



Experimental Planning

12-9 TP 1. Intro to labwork + SAFETY



BLOCK 1: Biomaterials mechanics and composition

19-9 TP 2 . Preparation of materials and calculations
26-9 TP 3. Gelation experiments Ca vs Gelatin (split groups)

BLOCK 2: Cell culture and surface interactions

3-10 TP 4. Cell splitting / microscopy (split groups)
10-10 TP 5. Cell splitting / microscopy (split groups)

17-10 TP 6. Cytotoxicity/ make gels / rheology (split groups)
--- break ---
31-10 TP 7. Cytotoxicity/ make gels / rheology (split groups)
7-11 TP 8. Cytotoxicity/ make gels / rheology (split groups)

14-11 TP 9. Live-dead / nanolive / report (split groups)
21-11 TP 10. Live-dead / nanolive / report (split groups)
28-11 TP 11. Live-dead / nanolive / report (split groups)

BLOCK 3: ”Tissue Engineering”

5-12 TP 12. Gel – Cell function / Essay prep (split groups)
12-12 TP 13. Gel – Cell function / Essay prep (split groups)
18-12 Hand in of lab essay papers

**Don’t wait till the end to write the essay!
Plan a bit of time every week and
ASK TA’s for HELP**

Hydrogels

1.	Safety & lab 123	Exp. Disc. Class 456	
	Exp. disc class 456	Safety & lab 123	
2	Intro to chemical calculations		
	Ca Sol. 1+2	Alg. Sol. 3+4	Gel. Sol. 5+6
3	Gelation Gelatin 123	Gelation Ca/Alg 456	
	Gel inversion test analysis		

Cell culture and gel prep

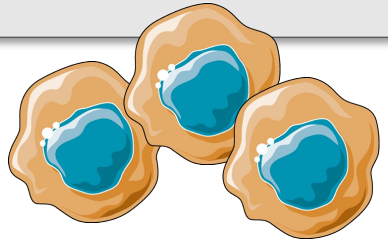
6	Group 1&2 Cytotoxicity	Group 3&4 Make gels	Group 5/6 *Rheo anal.*
x	Fall break		
7	Group 1&2 *Rheo anal.*	Group 3&4 Cytotoxicity	Group 5/6 Make gels
8	Group 1&2 Make gels	Group 3&4 *Rheo anal.*	Group 5&6 Cytotoxicity

Tissue engineering

12	Groups 1,2,3 3D gels (rep 1)	Groups 4,5,6 -
13	Groups 1,2,3 -	Groups 4,5,6 3D gels (rep 2)
14	Submit assay DECEMBER 18 NOON on MOODLE	

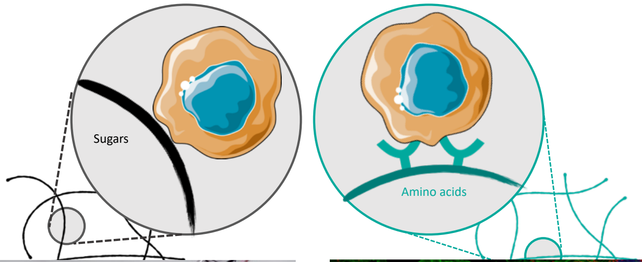
Cell culture

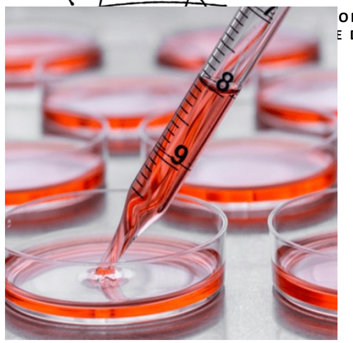
4.	Groups 1,2,3 Cell splitting	Groups 4,5,6 Microscopy
5.	Groups 1,2,3 Microscopy	Groups 4,5,6 Cell splitting

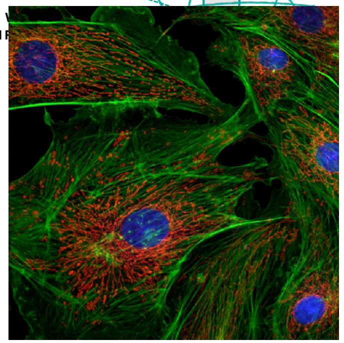


Cell culture and gel prep

9	Group 1&2 Live/dead	Group 3&4 Nanolive	Group 5/6 -
10	Group 1&2 -	Group 3&4 Live/dead	Group 5/6 Nanolive
11	Group 1&2 Nanolive	Group 3&4 -	Group 5&6 Live/dead







GOOD EXPERIMENTAL PRACTICE

Make an **HYPOTHESIS**	What do you expect to happen? And why?
Decide which **PARAMETER** to test	Vary only 1 parameter per experiment.
Think about your **CONTROLS**	Negative and positive, where possible.
Perform the **MEASUREMENTS**	Be as clean and precise as possible.
Present the **DATA**	Plot graphs, perform statistics.
Define a **CONCLUSION**	Based on the data. No more no less.
Present a **DISCUSSION**	What could have cause a change, difference from expectation… whats next?

Mass-Mole-Number Relationship

https://chemistry.coach/general-chemistry-2/chemical-calculations#mass-mole-number-relationship

Mole number n (in mol):

The number of moles in a sample is given by

$$n = \frac{m}{M}$$

m = mass of the substance (in g)
M = molar mass of the substance (in $g.mol^{-1}$)

$$n = \frac{N}{N_A}$$

N = number of particles in the substance
N_A = Avogadro's number = $6.022 \times 10^{23}\ mol^{-1}$

Ex:

- **Mass to moles:**

Calculate the number of mole in a 2.0 g sample of N_2:

$$n = \frac{m_{N_2}}{M_{N_2}}$$

$m_{N2} = 2.0\ g$
$M_{N2} = 2 \times M_N = 2 \times 14.0 = 28.0\ g.mol^{-1}$

$$\Rightarrow n = \frac{2.0\ g}{28.0\ g.mol^{-1}} = 7.1 \times 10^{-2}\ mol$$

Stoichiometry

Stoichiometry:

Stoichiometry is the part of chemistry that deals with the quantitative relationships between reactants and products in a chemical reaction. Stoichiometry is crucial for predicting the outcomes of reactions, optimizing reactant use, and determining reaction yields and limiting reactants. Balanced chemical equations serve as the foundation of stoichiometric calculations, ensuring that mass and atoms are conserved in chemical reactions.

Stoichiometric coefficients and mole ratios:

Stoichiometric coefficients are the numeric values written to the left of each species in a chemical equation to balance the equation. These coefficients can be interpreted as the number of molecules or the number of moles of a substance produced or consumed during the reaction. Mole ratios are derived from the coefficients of a balanced chemical equation.

Ex: $3\ H_2 + N_2 \rightarrow 2\ NH_3$

- Molecular interpretation: 3 molecules of H_2 react with 1 molecule of N_2 to form 2 molecules of NH_3.
- Molar interpretation: 3 moles of H_2 react with 1 mole of N_2 to form 2 moles of NH_3.

Molarity *M*:

Molarity is the number of moles of solute per liter of solution. It is commonly used in laboratories for reactions involving solutions, where volume measurements are convenient.

$$M = \frac{n_{solute}}{V_{solution}}$$

M = molarity (in $mol.L^{-1}$)
n_{solute} = moles of solute (in mol)
$V_{solution}$ = volume of solution (in L)

Dilution formula:

The relationship between the concentrations and volumes of the stock and diluted solutions is given by:

$$C_1V_1 = C_2V_2$$

C_1 = initial concentration (stock solution)
V_1 = initial volume (stock solution)
C_2 = final concentration (diluted solution)
V_2 = final volume (diluted solution)

Ex:

> How much of a 2.0 M NaCl stock solution is needed to prepare 500 mL of a 0.5 M NaCl solution?
>
> - $C_1 = 2.0$ M; $C_2 = 0.5$ M; $V_2 = 500$ mL
> - $C_1V_1 = C_2V_2 \Rightarrow (2.0\text{ M})\ V_1 = 0.5\text{ M} \times 500\text{mL}$
> - $V_1 = \frac{0.5\text{ M} \times 500\text{ mL}}{2.0\text{ M}} = 125\text{ mL}$

Steps for dilution:

1. Determine the final concentration and volume needed.
2. Calculate the volume of stock solution needed: use the dilution formula to calculate V_1.
3. Add enough solvent to the stock solution to reach the final volume V_2.

Reaction Yield

Theoretical vs. actual yield:

- Theoritical yield: The maximum amount of product that can be produced from a given amount of reactants, based on stoichiometric calculations.
- Actual yield: The amount of product actually obtained from a reaction.

Percent yield:

Percent yield is a measure of the efficiency of a reaction, calculated as the ratio of the actual yield to the theoretical yield, expressed as a percentage. Percent yield is a critical parameter for evaluating the success of a reaction and for comparing the efficiency of different synthetic methods.

$$\% \text{ yield} = \frac{\text{actual yield}}{\text{theoretical yield}} \times 100$$