Biomaterials for MX

MSE – 471 (2024)

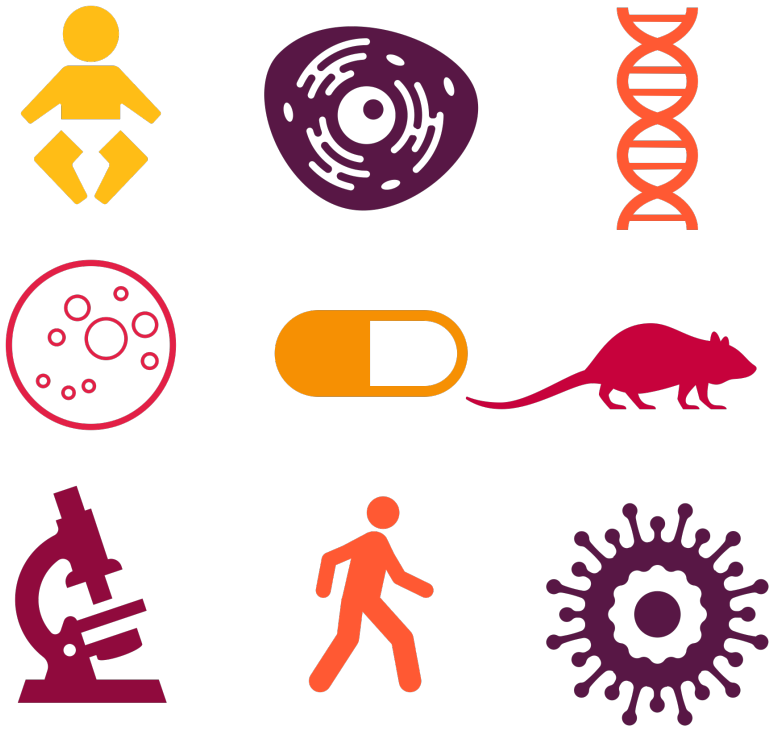
Prof. Maartje M.C. Bastings

Experimental Sessions at DLL

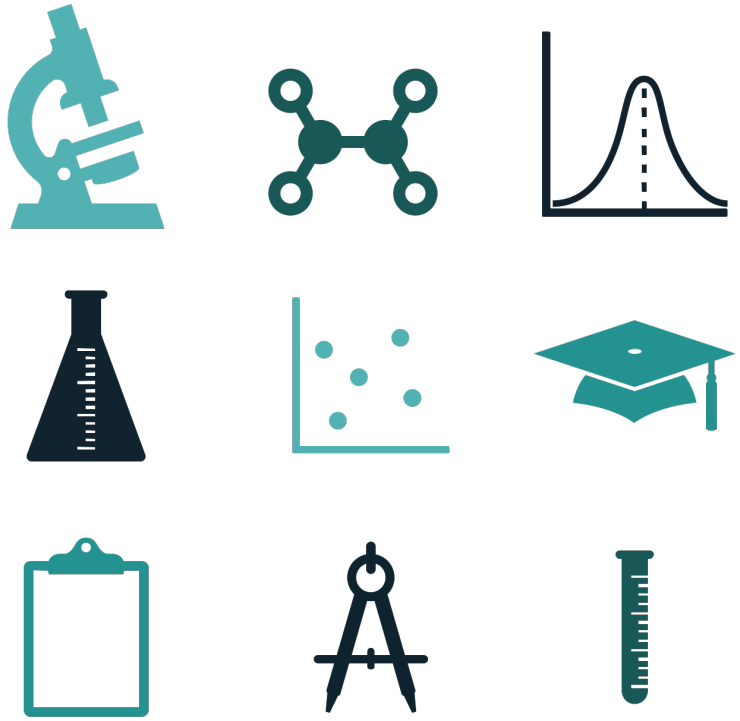
The Biomaterial Interface

*A mysterious intersection where **engineering** and **nature** (should) meet*

Biology



Materials



The Biomaterial Interface

*A mysterious intersection where **engineering** and **nature** (should) meet*

Biology

Cell adhesion

Immune activation

Membrane receptors

Cellular entry

Bones and joints

Materials

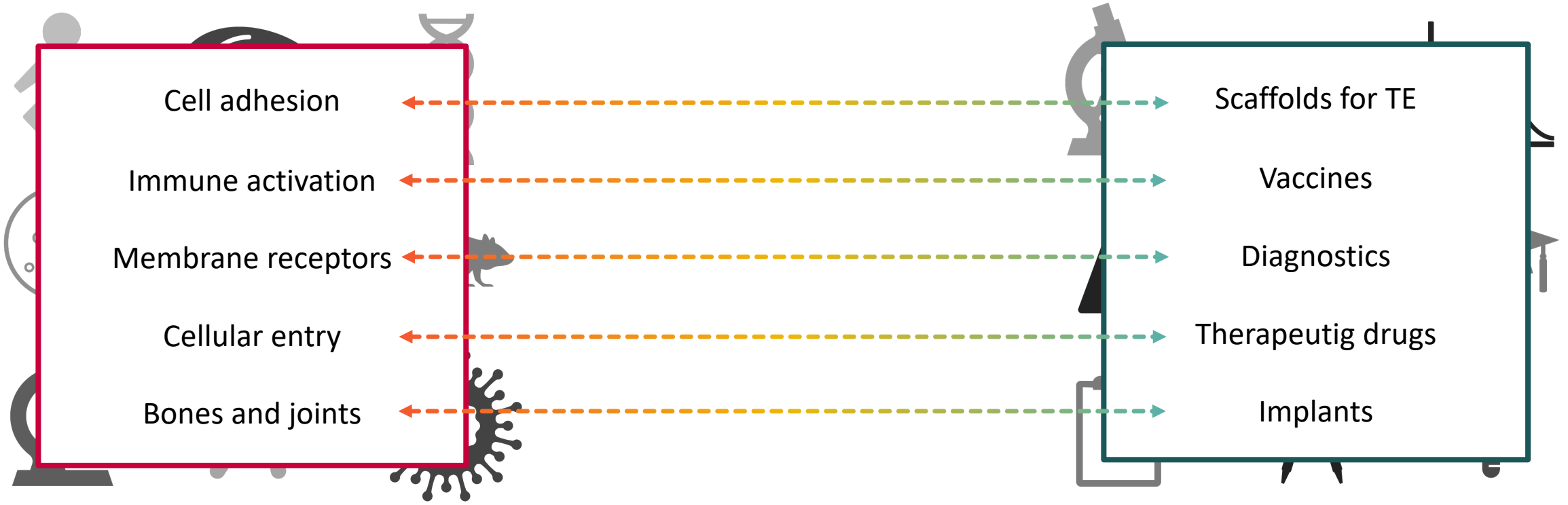
Scaffolds for TE

Vaccines

Diagnostics

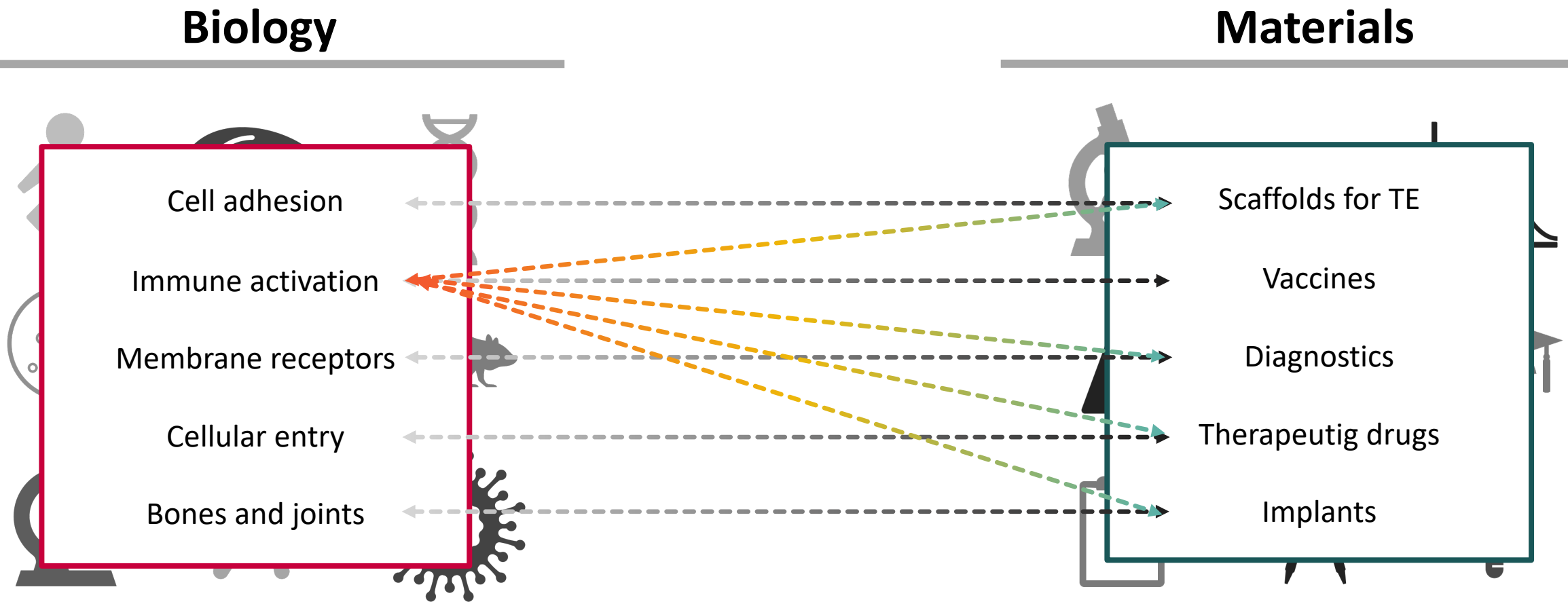
Therapeutig drugs

Implants



The Biomaterial Interface

*A mysterious intersection where **engineering** and **nature** (should) meet*



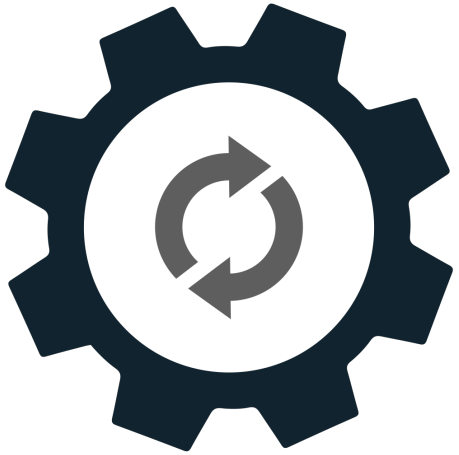
The Biomaterial Interface

*A mysterious intersection where **engineering** and **nature** (should) meet*

Biology

- Cell adhesion
- Immune activation
- Membrane receptors
- Cellular entry
- Bones and joints

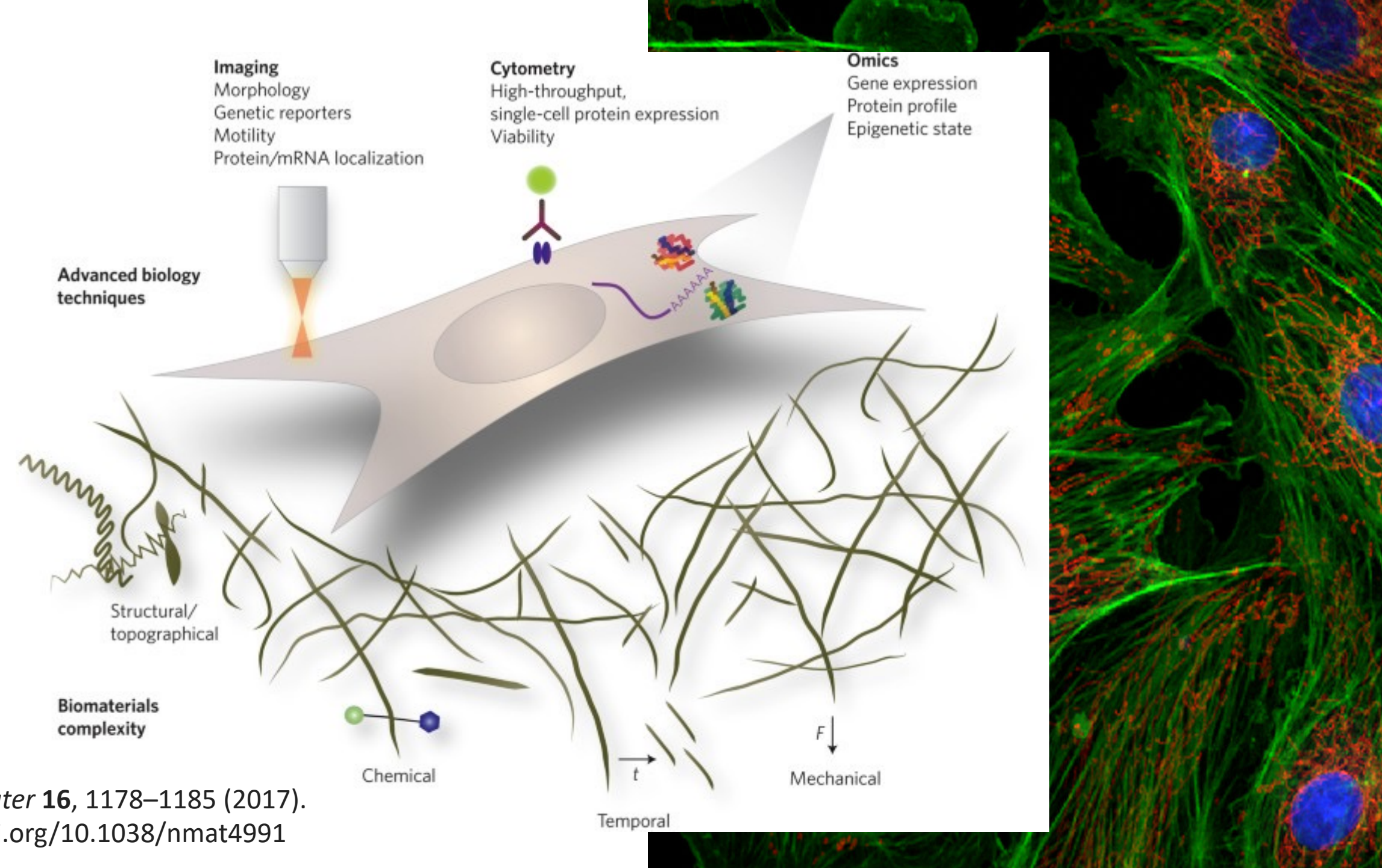
understand interactions



to engineer function

Materials

- Scaffolds for TE
- Vaccines
- Diagnostics
- Therapeutig drugs
- Implants

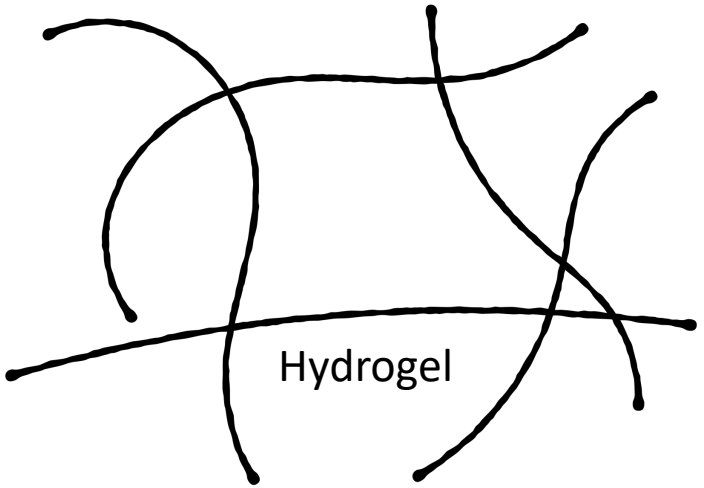


Nature Mater **16**, 1178–1185 (2017).
https://doi.org/10.1038/nmat4991

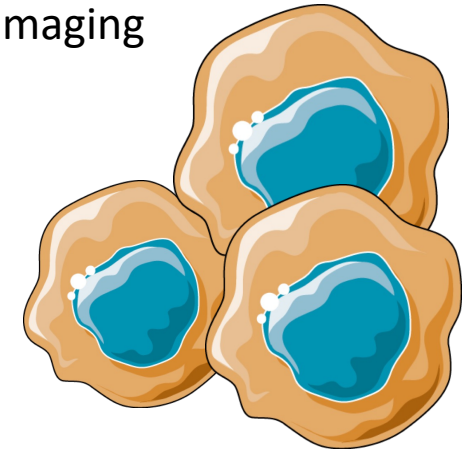
Labs : hands on research project in biomaterials

3 modules: from **chemistry**, via **characterization** and **image analysis**, to **biology**

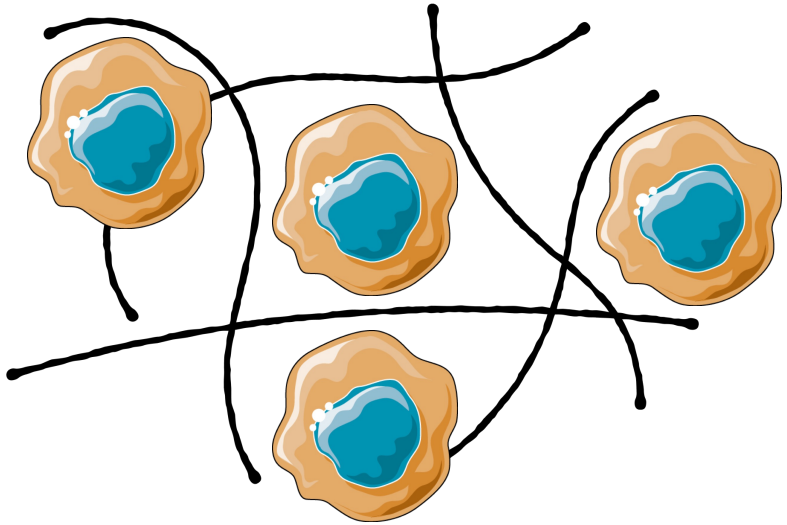
Soft biomaterials



Cell culture
& Imaging



Tissue engineering

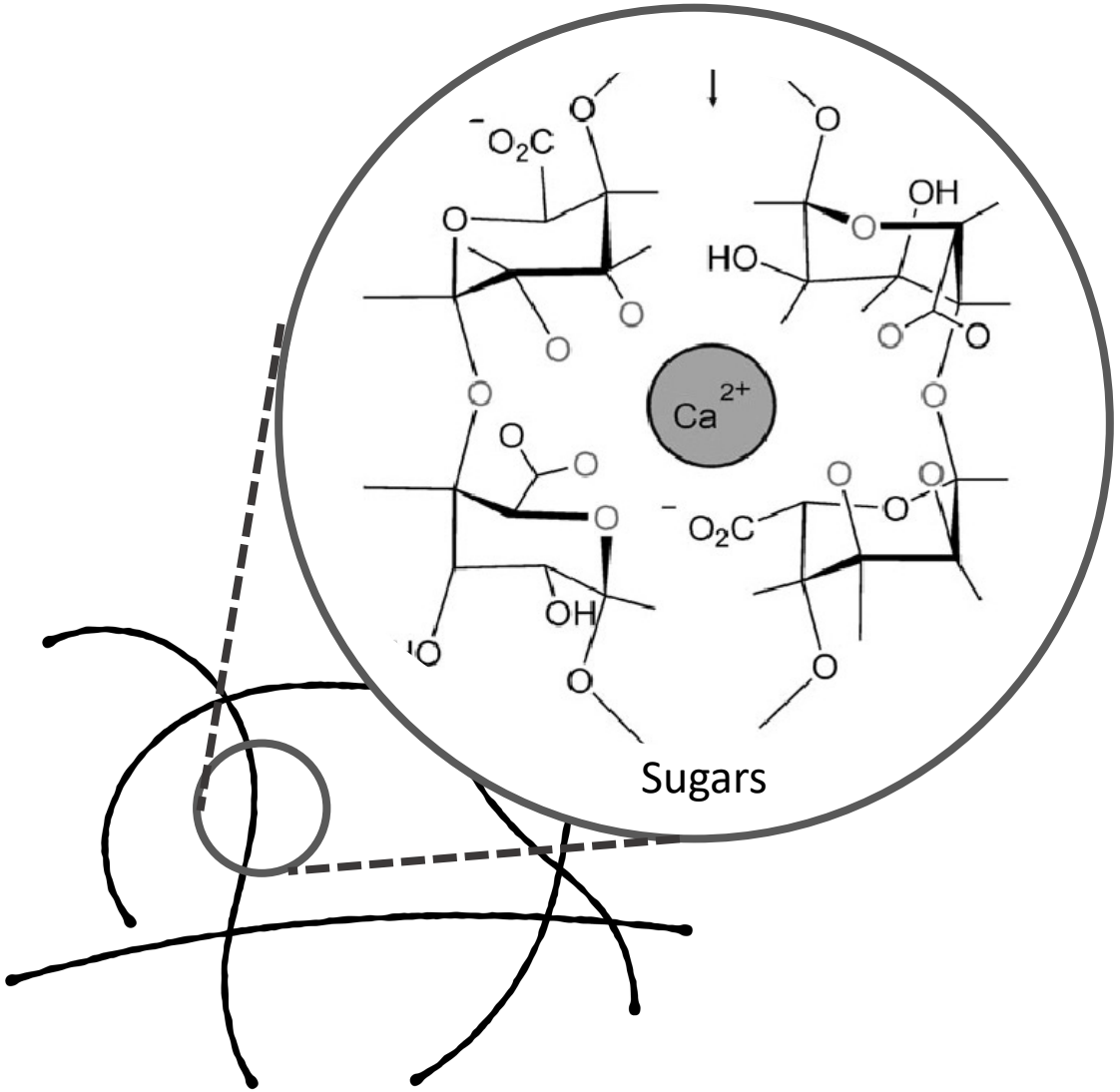


PLANNING 1 week intro, 2x 5 weeks, last 2 weeks for assay writing.

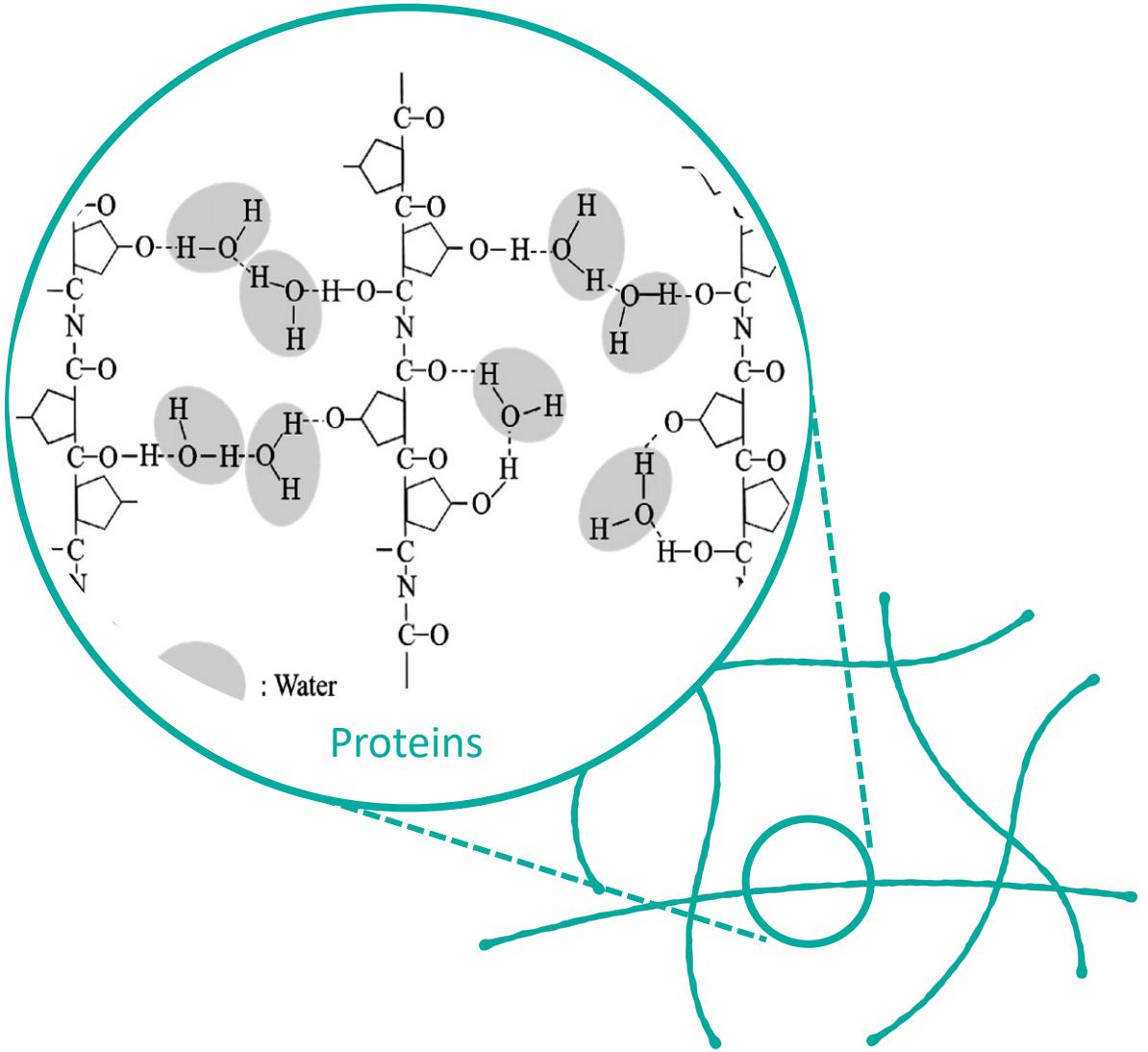
GROUPS Limit chaos and overcrowding at DLL, split in groups and rotate
NB: the preparation is mandatory and will allow for a smooth sailing of the lab work

INDIVIDUAL lab reports (will be graded!) final hand in last class of semester (18th December @ noon)

Block 1: Surface chemistry and Cell adhesion



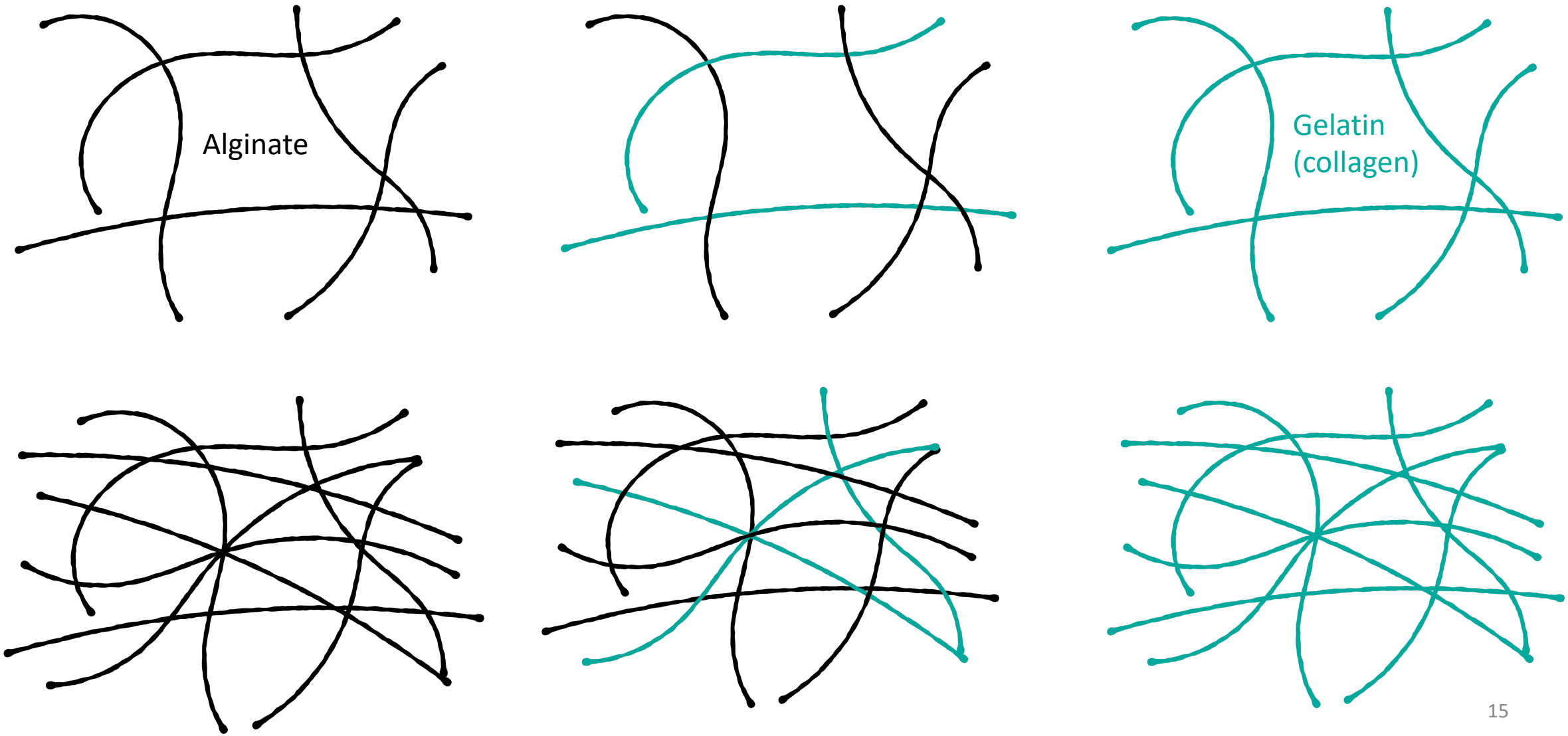
Alginate



Gelatin

BLOCK 1: Stiffness of Scaffolds

How to control mechanical properties and chemical identity of biomaterial scaffolds



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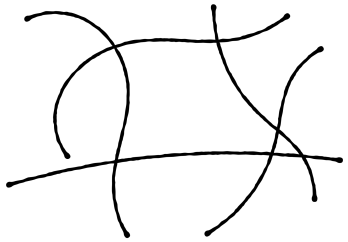
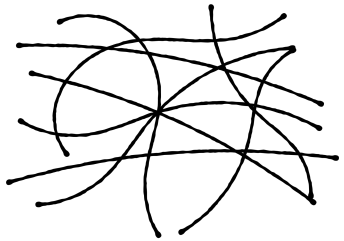
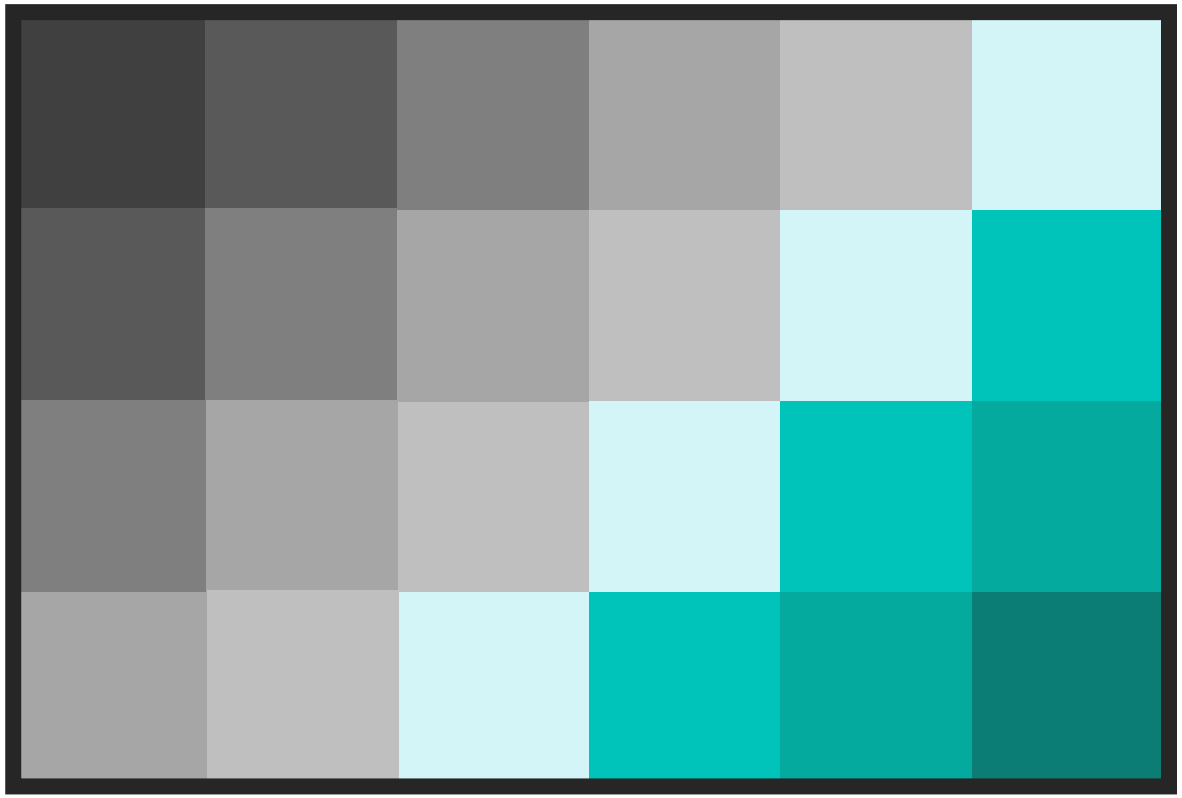
How to control mechanical properties and chemical identity of biomaterial scaffolds

Alginate



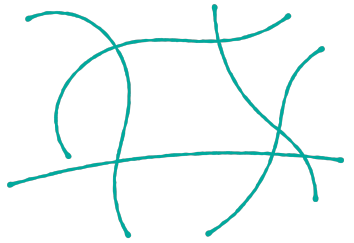


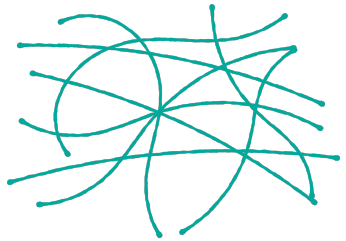
Increase in stiffness



Increase in cell adhesion sites

Gelatin





Increase in cell adhesion sites

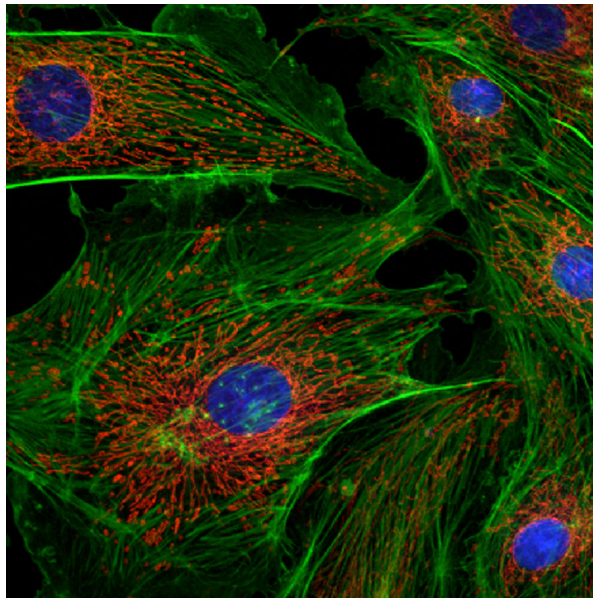
Block 2: Cell culture and viability

Develop cell culture skills

Cell counting, splitting, washing

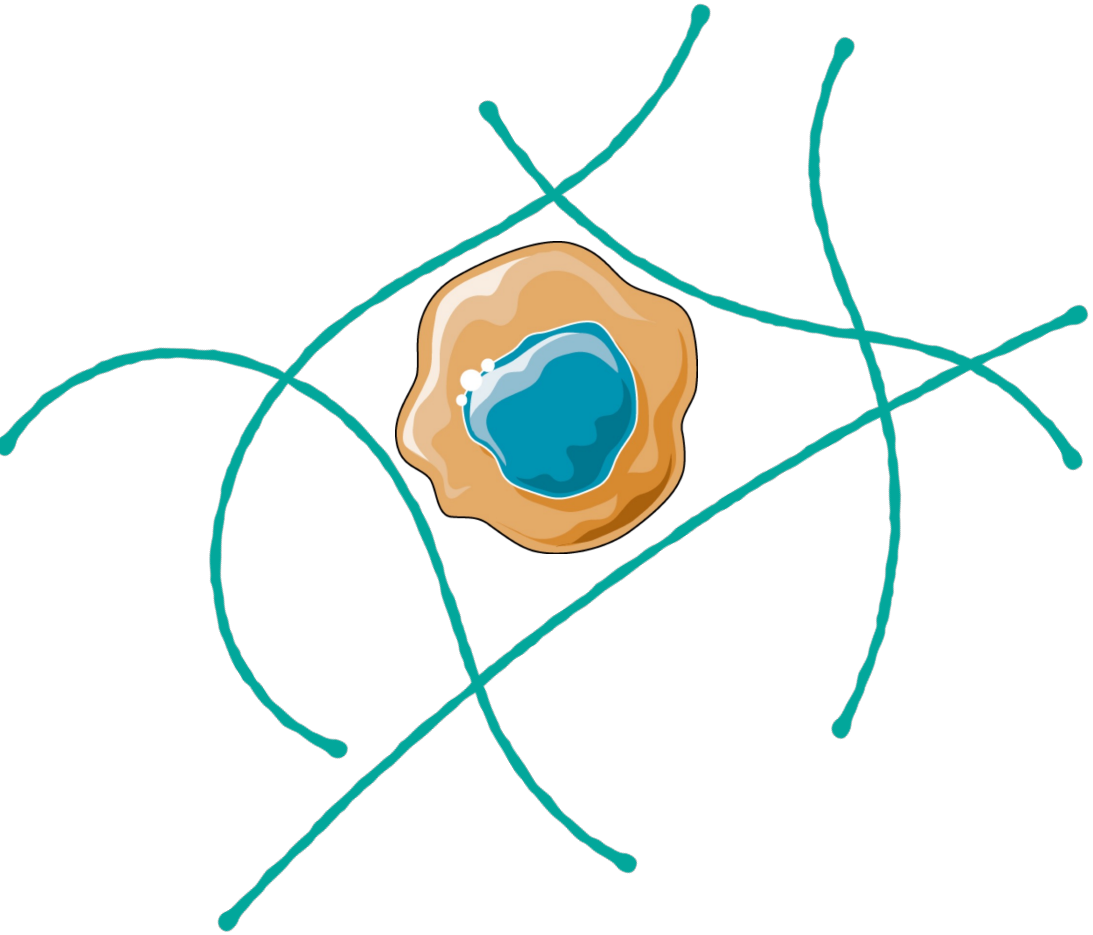
Staining of nucleus

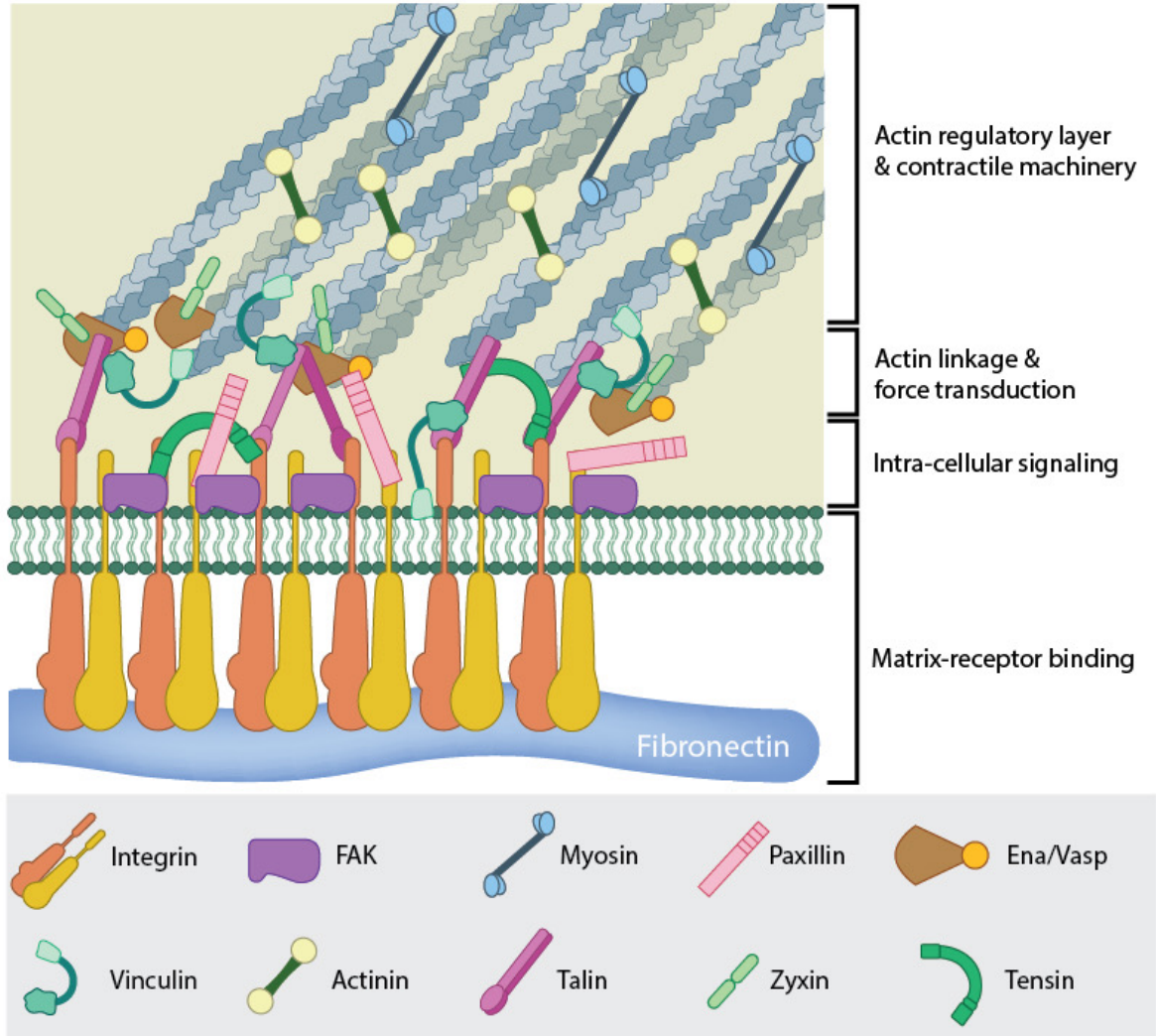
Live-dead assay (viability)



Block 3: Imaging of cell response to materials

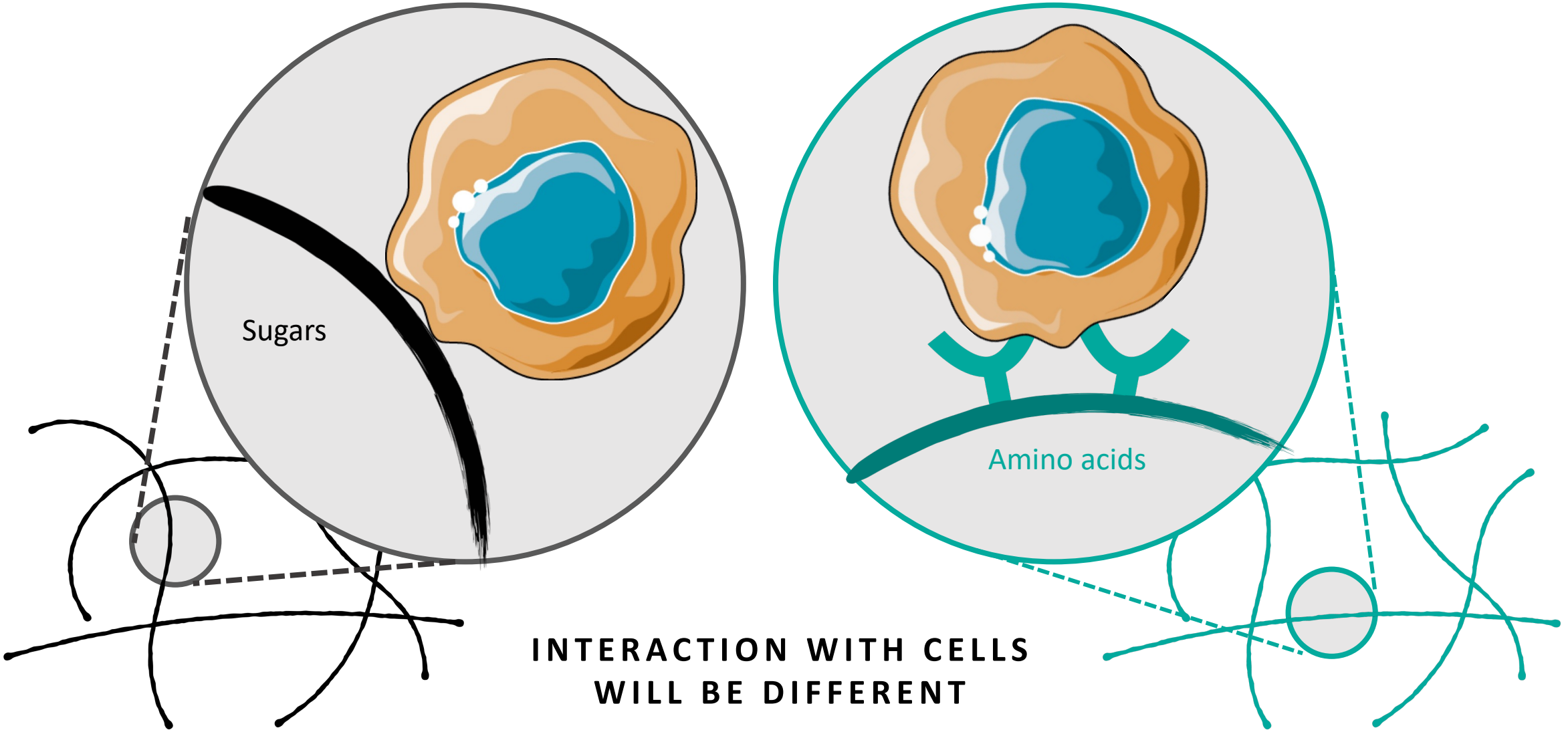
FOCAL ADHESION FORMATION AND CYTOSKELETON





https://www.mechanobio.info/what-is-mechanosignaling/what-is-the-extracellular-matrix-and-the-basal-lamina/what-are-focal-adhesions/what-are-mature-focal-adhesions-composed-of/

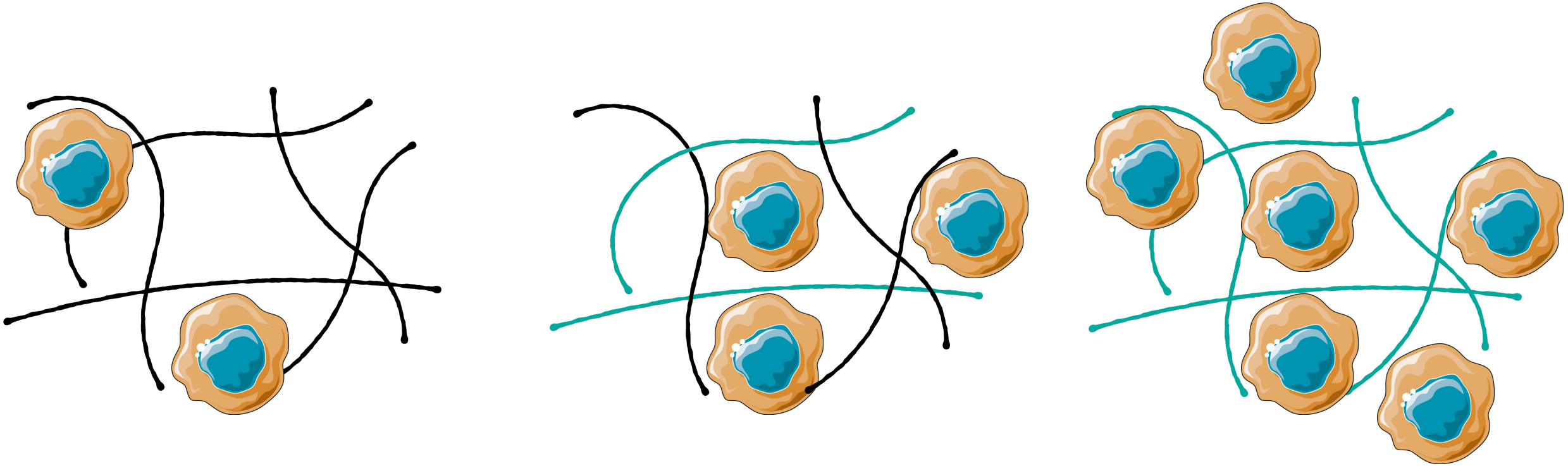
Block 3: Surface chemistry and Cell adhesion



Block 3: Imaging of cell response to materials

Non adhesive?

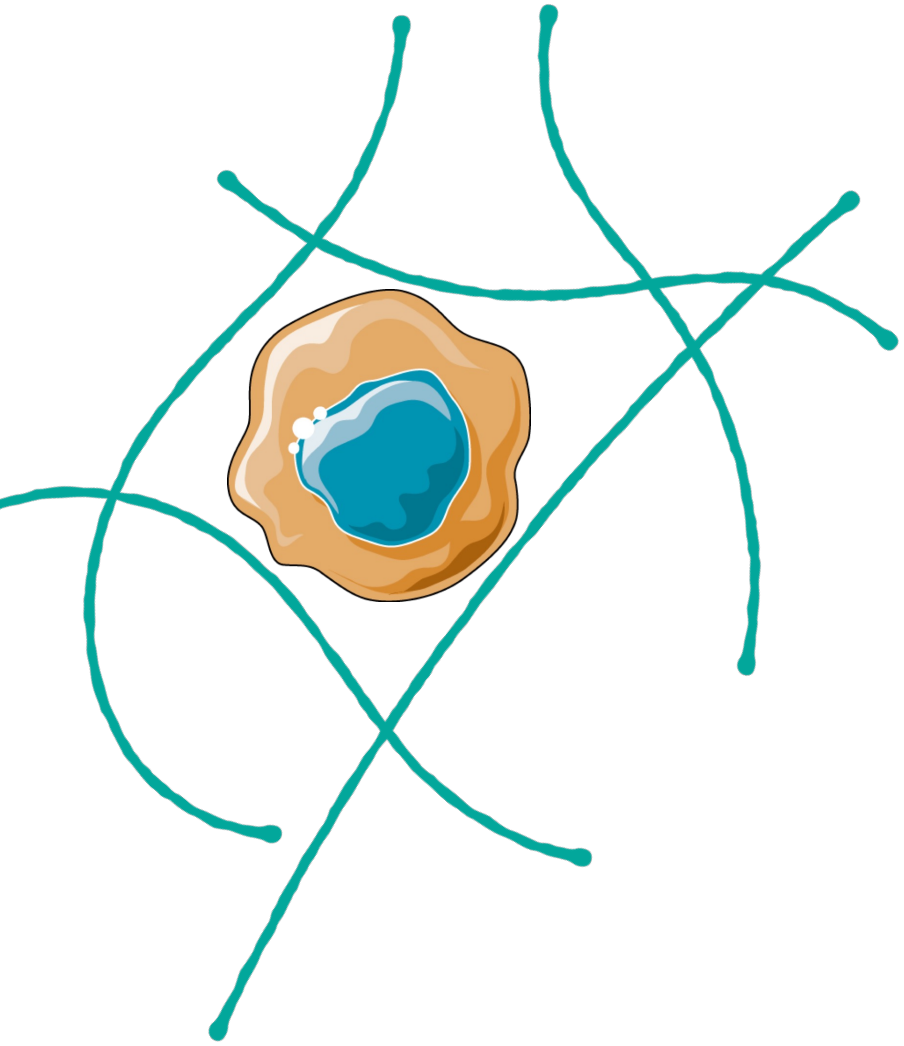
Strong adhesive?

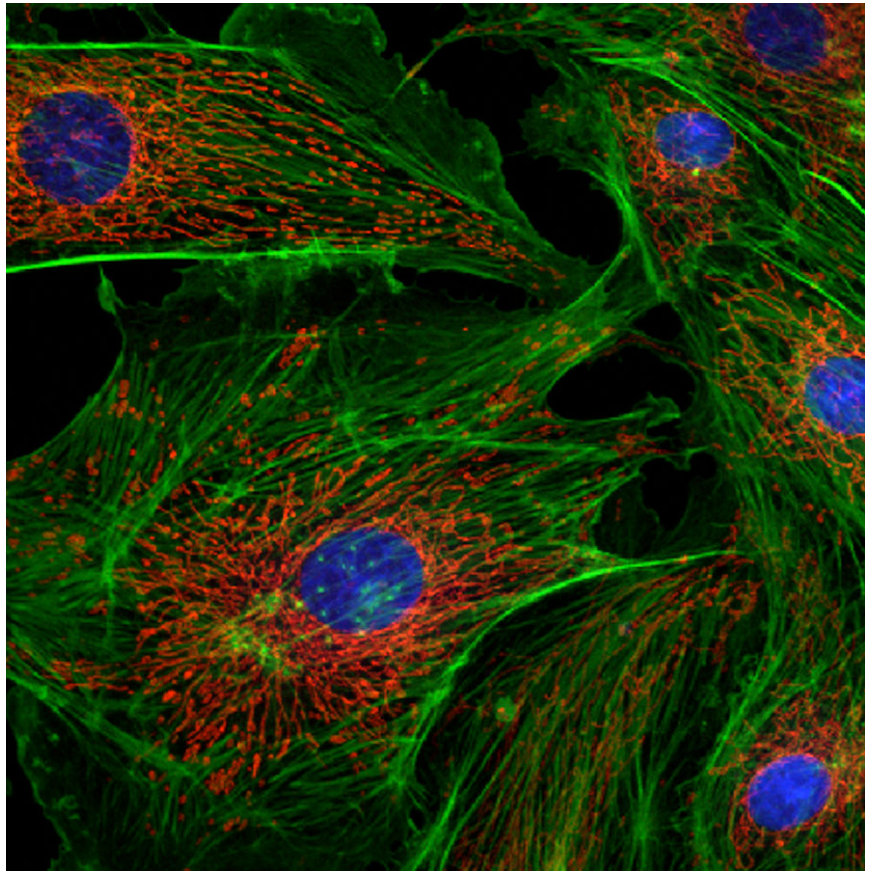


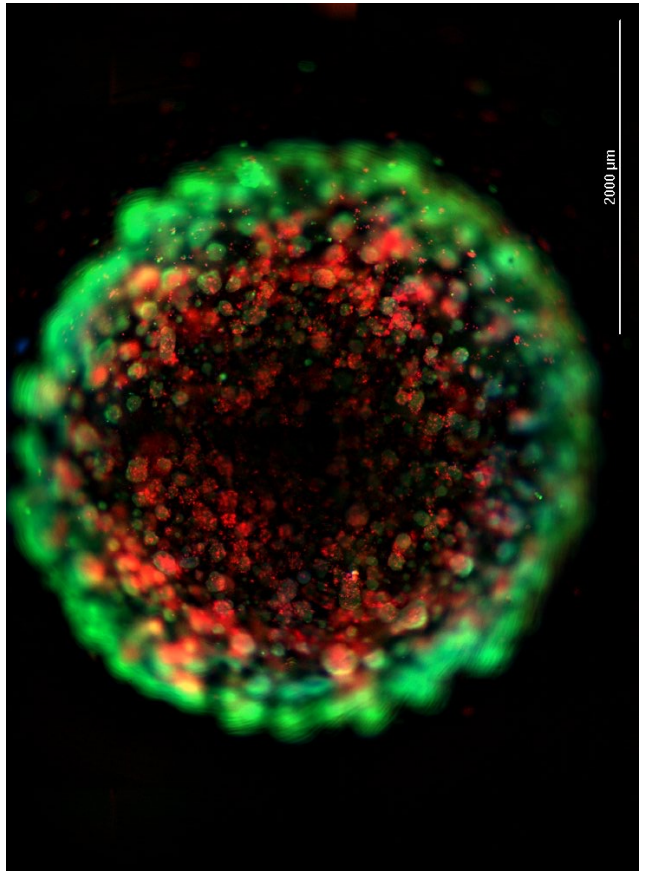
CELL ADHESION

Block 3: Imaging of cell response to materials

FOCAL ADHESION FORMATION AND CYTOSKELETON







AIM OF THESE SESSIONS

LEARN HOW TO **DESIGN** A GOOD EXPERIMENT

PROVIDE **EXPERIENCE** WITH BIOMATERIALS

EXPLORE THE BIOINTERFACE

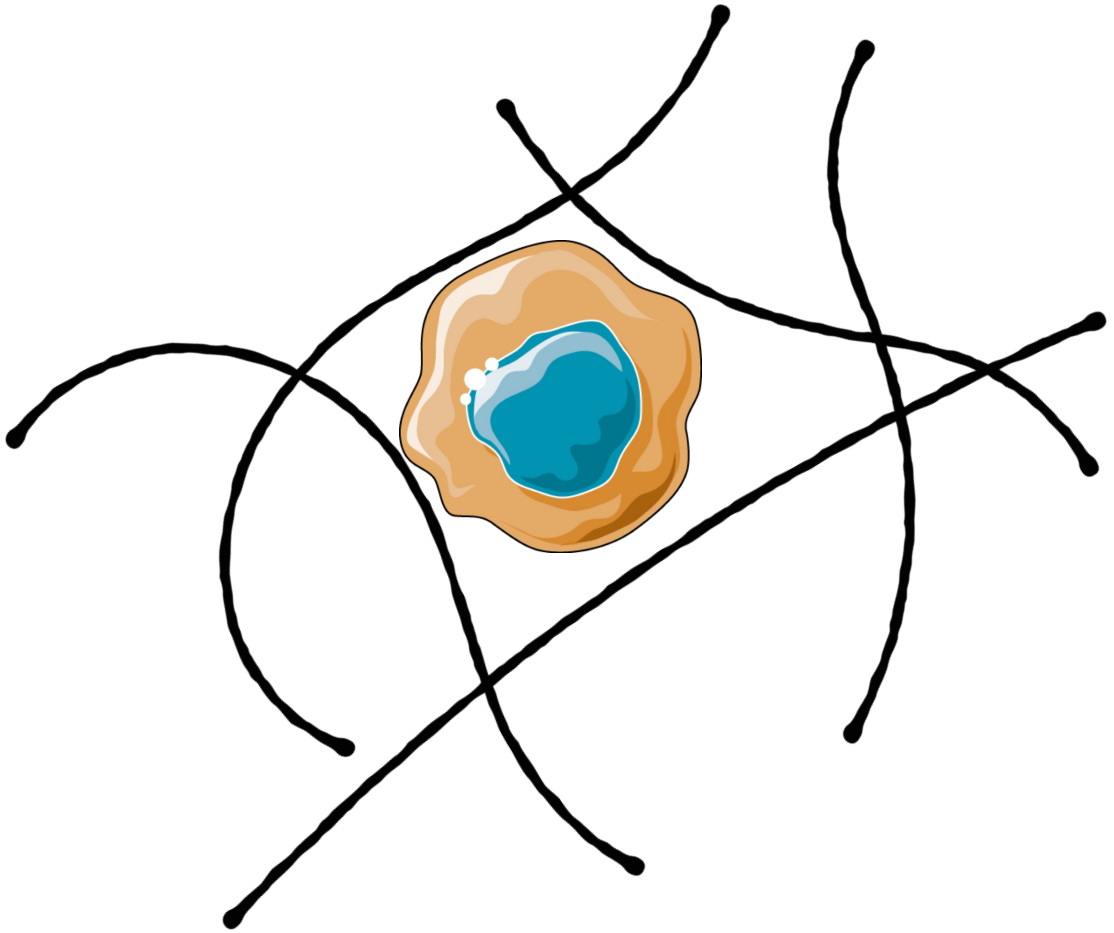
APPLY THEORETICAL CONCEPTS

HANDS ON CELL WORK

STEPPING STONE FOR **FUTURE RESEARCH** PROJECTS

HOW TO **WRITE** A SCIENTIFIC REPORT

MAKE **MISTAKES** WITHOUTH SERIOUS CONSEQUENCES



THE **LAB REPORT** IS A SHORT RESEARCH PAPER WHICH WILL BE GRADED AND IS 30% OF YOUR GRADE

WE WILL WORK ON THIS GRADUALLY DURING THE SEMESTER – **INDIVIDUAL EFFORTS**!

Write an experimental paper based on your lab notes

Title

Abstract

Introduction

Research questions

Hypothesis

Experimental setup

Results

Conclusion

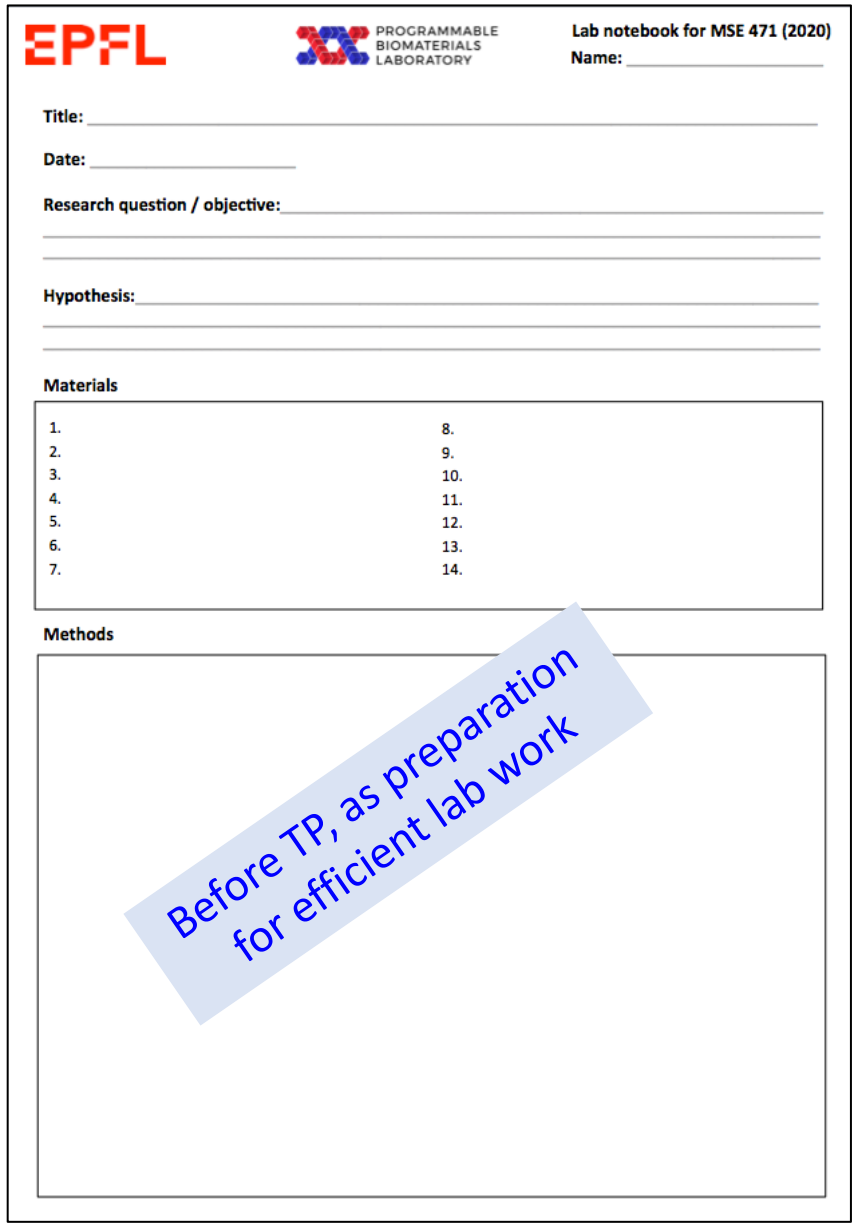
Discussion

References

Max 5 pages
Include your analyzed data
Images
Use TA's and Zoom sessions for feedback

PDF by email latest Wednesday 18 DECEMBER by NOON

Taking good lab notes



EPFL PROGRAMMABLE BIOMATERIALS LABORATORY

Lab notebook for MSE 471 (2020)
Name: _____

Title: _____

Date: _____

Research question / objective: _____

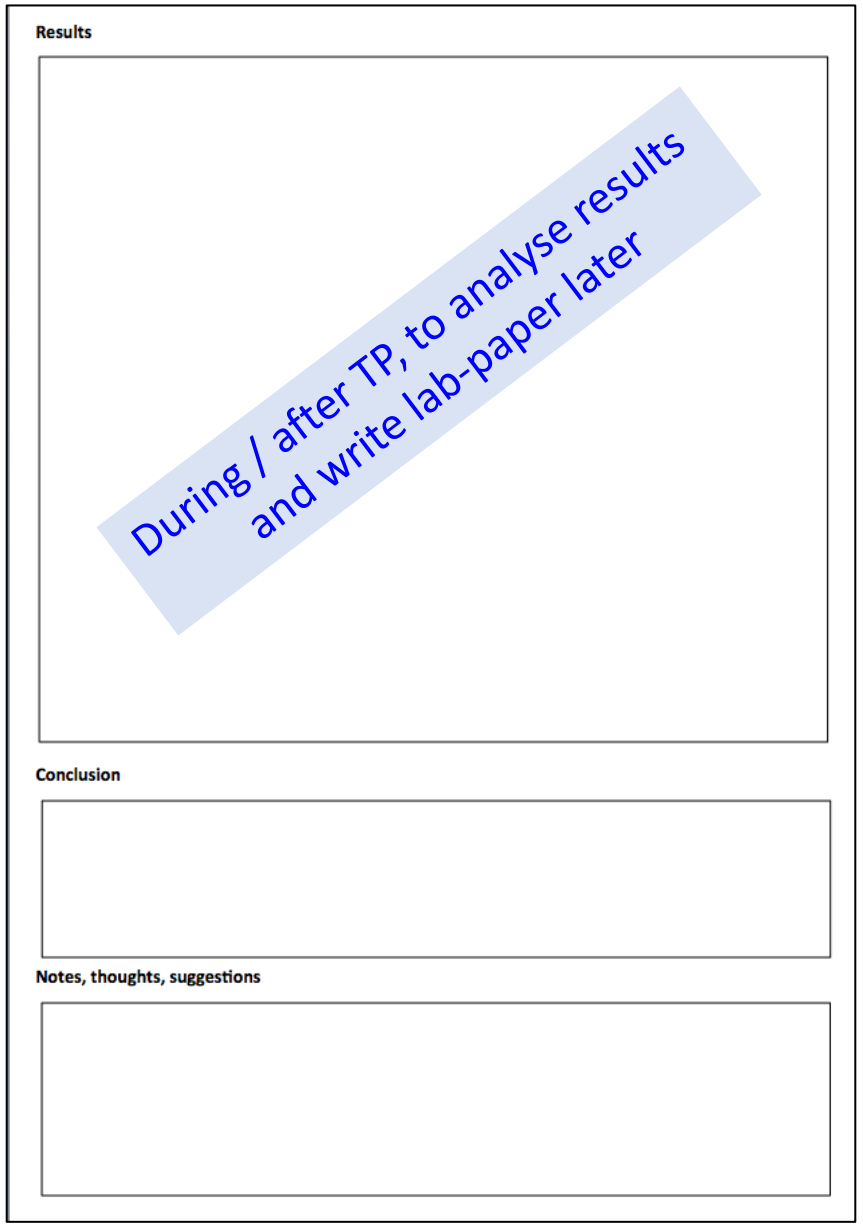
Hypothesis: _____

Materials

1.	8.
2.	9.
3.	10.
4.	11.
5.	12.
6.	13.
7.	14.

Methods

Before TP, as preparation for efficient lab work



Results

During / after TP, to analyse results and write lab-paper later

Conclusion

Notes, thoughts, suggestions

Print out the lab notebook sheet (1 per TP, so you need 4 in total)

Also in the PDF bundle of all TPs on MOODLE

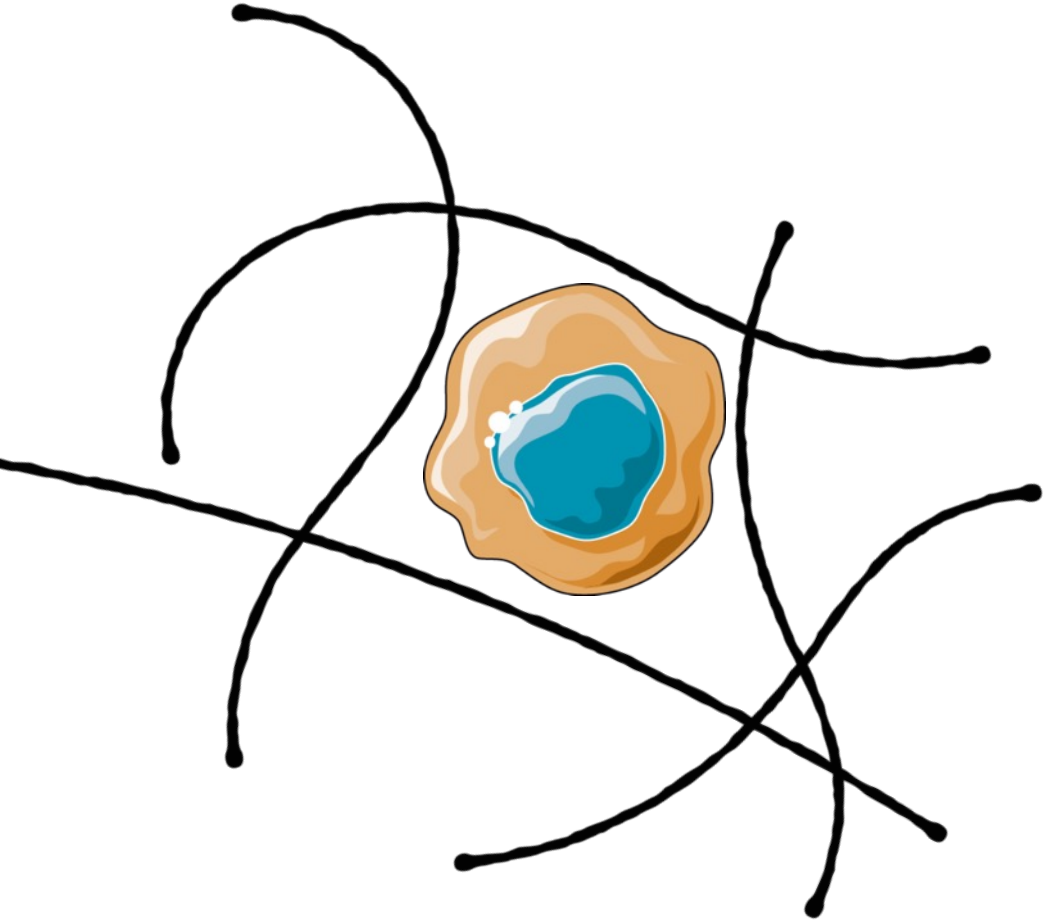
BEFORE TP, read protocol, fill in the following sections:

- Title
- Objective / question
- Hypothesis
- Materials (based on protocol, can change during TP)
- Short outline of Methods

→ USE TA's for questions on the above **BEFORE your TP**

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)

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

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

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

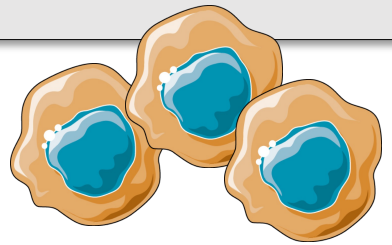
6	Group 1&2 Cytotoxicity	Group 3&4 Make gels	Group 5/6 *Rheo anal.*
x	Fall break		
7	Group 1&2 *Rheo anal.*	Group 3&4 Cytotoxicity	Group 5/6 Make gels
8	Group 1&2 Make gels	Group 3&4 *Rheo anal.*	Group 5&6 Cytotoxicity

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	

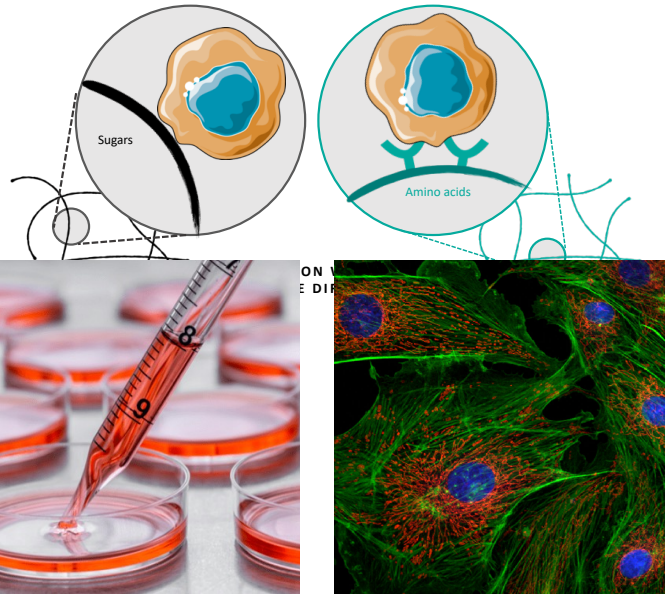
Cell culture

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



Exams and Grading

LAB-PAPER:

30% of grade

Based on your experimental design choices and data, you will write a short publication style report (max 5 pages, TOTAL), highlighting your hypothesis, results, discussion and conclusions.

Individual papers, submitted on last day of class, WEDNESDAY DECEMBER 18 AT NOON

Submission on MOODLE. LATE SUBMISSION = -0.5 on the grade of your lab paper.

WRITTEN EXAM:

70% of grade

In the exam period, on the material covered during the lectures.

House rules:

1. Lab hours are mandatory and very limited time, be in time and be prepared
2. **Thursday 8.15-10 (very short amount of time to be in the lab, use it well)**
3. Per block, work on your data interpretation and ***discuss with the TAs***
4. **Don't wait until the last week** of the semester to write your report…
5. Reports are **INDIVIDUAL**, no plagiarism! **Failed experiments do not mean a bad report**
6. **You will not need all 3 weeks in the lab for your experiment, use the rest of the time for the report**

There will be choices to make, focus on 1 parameter and don't try to do too much.

Better to do 1 thing carefully and well, than too many unfinished datapoints.

We are with a big group, please be patient to the TA's, and don't expect magic from them

(if you come with 20 at the same time in the last 20 mintues, there will not be enough time)

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?

Organization

Course Responsible

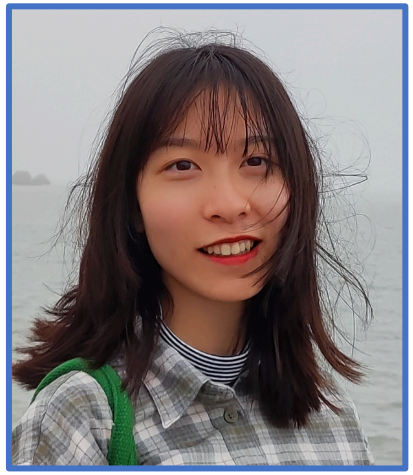
Prof. Maartje M.C. Bastings
maartje.bastings@epfl.ch

DLL Responsible

Phillippe Abdel Sayed
philippe.abdel-sayed@epfl.ch

DLL TEACHING ASSISTANTS

Pitt



Shujie

Yameng

Sandra

Herbert

Pauline

General BioLab Rules (and advice)

NO eating and drinking in the lab

Lab coats and gloves are mandatory.

Do not touch doors and your cell phone with your lab gloves.

Take pen and paper with you to make notes on observations / datapoints.

Split in groups, follow advice from TAs, work together when possible.

Ask questions.

Neglect of safety and/or inappropriate behaviour might lead to exclusion from the DLL