Novel Microcarriers for the Scalable Production of Cultivated Meats

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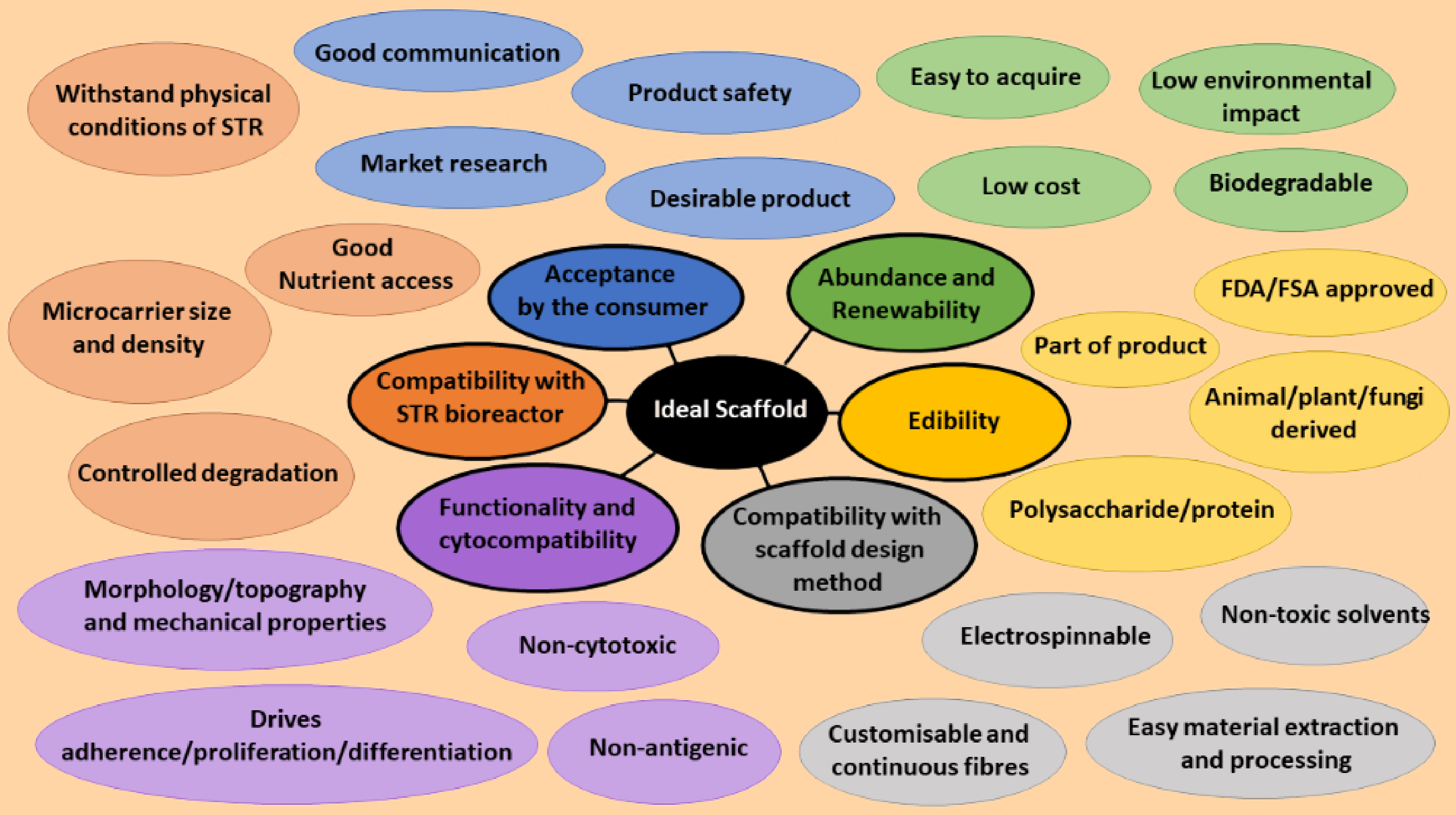
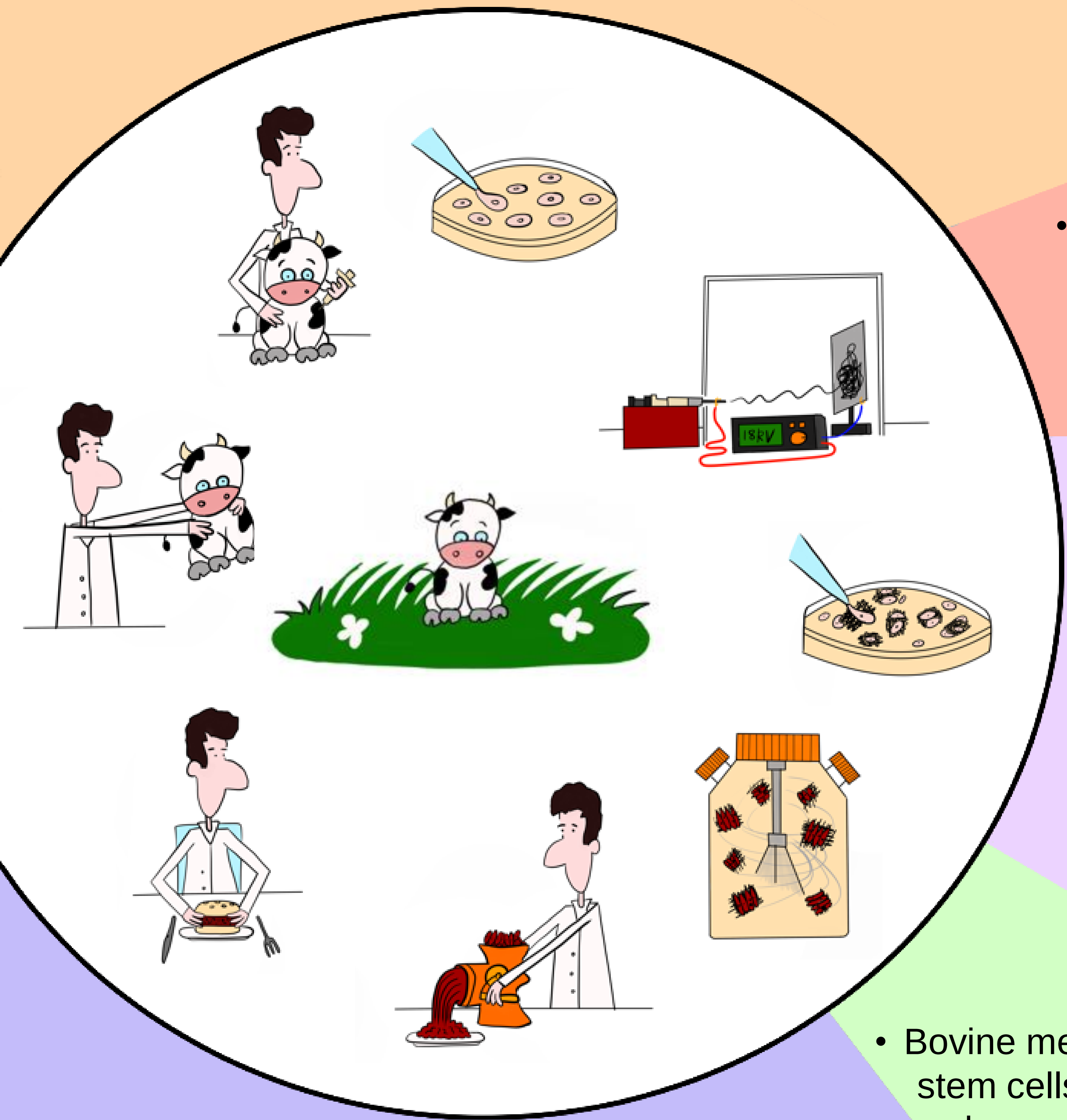
Project Aims

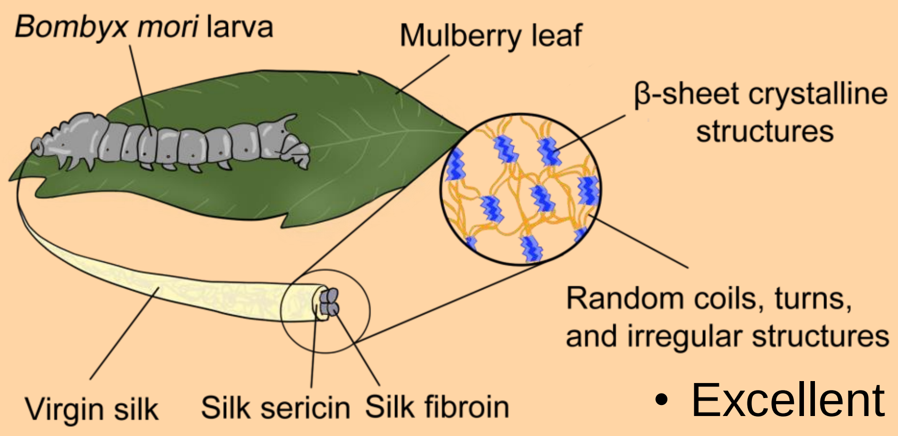
- *Screen and characterise suitable edible biomaterials & engineer scaffolds*
- *Culture, expand and differentiate bovine mesenchymal stem cells in static conditions*
- *Engineer microcarriers from scaffolds and scale up the process to bioreactors*
- *Improve consumer acceptance for cultivated meats*
- *Provide standards for the textural properties of cultivated beef burgers*

The Ideal Scaffold



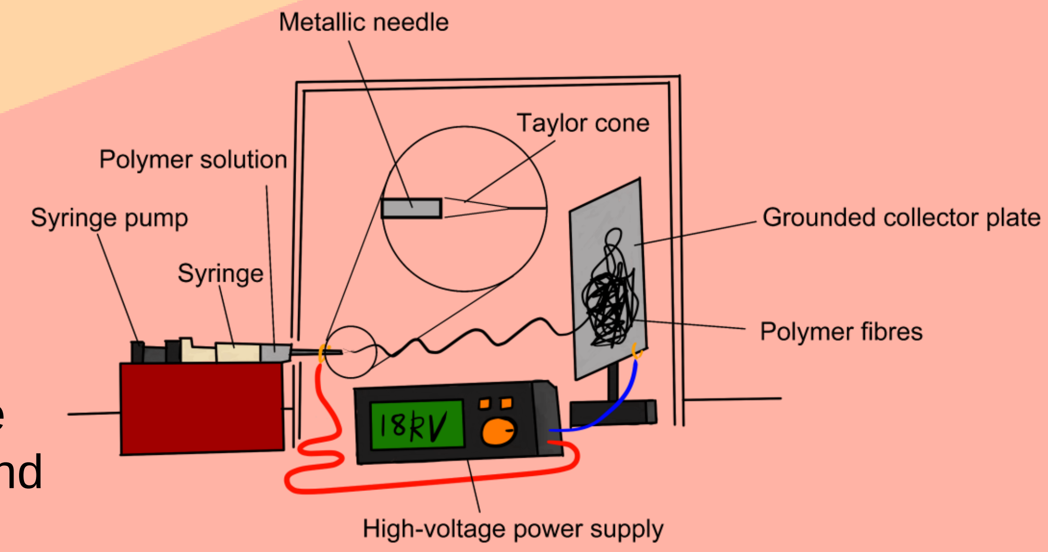


Silk Fibroin (SF)



- Naturally secreted protein derived from virgin silk.
- Abundant, cheap and edible.
- Excellent cytocompatibility, physical and mechanical properties.
- Used in textiles, tissue engineering, filtration systems and as a food preservative.

Electrospinning



- Cheap, scalable and versatile method of producing nano- and micro-fibrous scaffolds with interconnected pores, mimicking the native extracellular matrix.
- Uses electrostatic forces to draw a polymer solution into fibres.

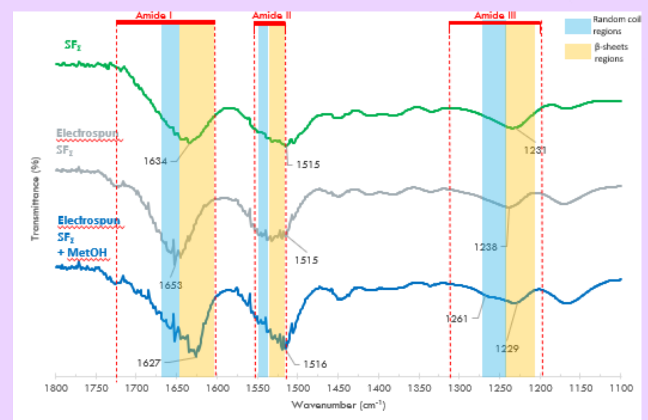
Scaffold production

Methanol treatment of the SF scaffolds:

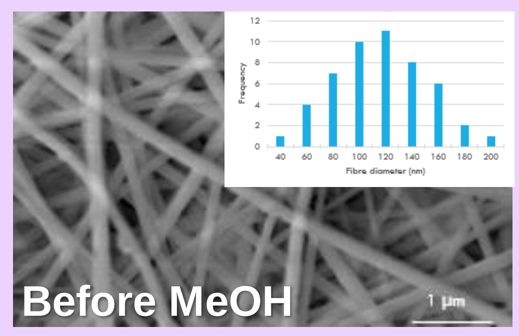
- Improved the scaffolds' handleability, tensile properties and hydrophobicity.

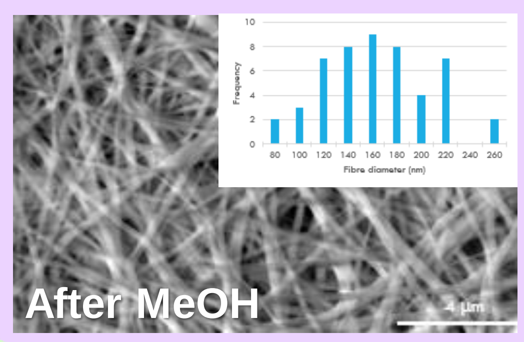
MetOH Treatment	Young's modulus (MPa)	Ultimate Tensile Strength (MPa)	Strain at Break (%)
Untreated	189.37	6.27	13.96
Treated	1625.48	18.62	1.34

- Changed SF's secondary structure



- Affected fibre diameter and morphology.

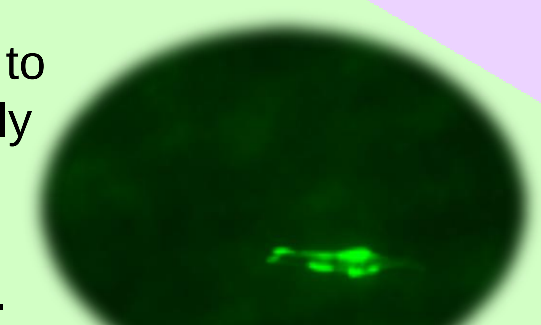




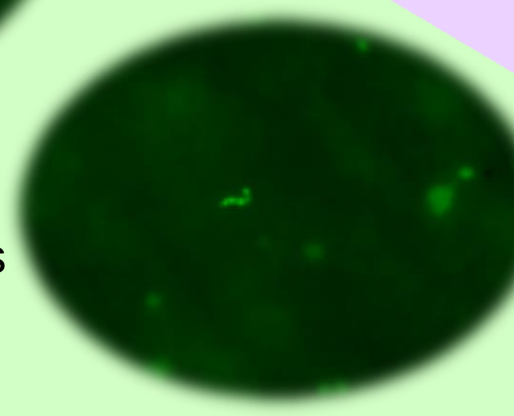
- Increased SF's β-sheet content and crystallinity.

Scaffold Characterisation

- Bovine mesenchymal stem cells (bMSC) were chosen for their ability to differentiate into muscle and fat lineages.
- Cells were shown to grow successfully on silk fibroin electrospun scaffolds.



- Cells exhibited both elongated and rounded morphologies, which is ideal for muscle and fat lineages.



- Cells appeared to permeate the scaffold pores.

Cell Culture

- The mechanical properties of burgers with different fat contents and consumer perceived quality (based on reviews) were measured.
- These measurements aim to provide **a standard** for cultivated meats to mimic the textural properties of traditional meat.

		Tensile properties		Flexural properties		Compressive properties	
	Test sample	E (kPa)	UTS (kPa)	Ebend (kPa)	UFS (kPa)	k (kPa)	UCS (kPa)
Raw	20% fat High Quality	5	2.2	6.6	3	11.7	10.3
	20% fat Low Quality	9.1	4	12.9	5.1	18.5	18.2
Cooked	20% fat High Quality	60.1	15.2	108.5	27.6	147.4	63.6
	20% fat Low Quality	70.1	19.3	118.4	43.8	205.4	137.7

- Burgers perceived as higher quality were more tender.
- The cooked samples were a approximately 10 x stiffer than the raw ones.

Meat Texture Analysis

Conclusions

- *Silk fibroin scaffolds were created using electrospinning.*
- *MeOH treatment affected fibre morphology, strength and protein secondary structure.*
- *Silk fibroin scaffolds supported bMSC growth.*
- *Early work on mechanical properties of beef burgers identified desirable textural properties for cultivated meats.*

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