MEAT LESS:
CREATING A HEALTHIER AND MORE SUSTAINABLE FOOD SUPPLY

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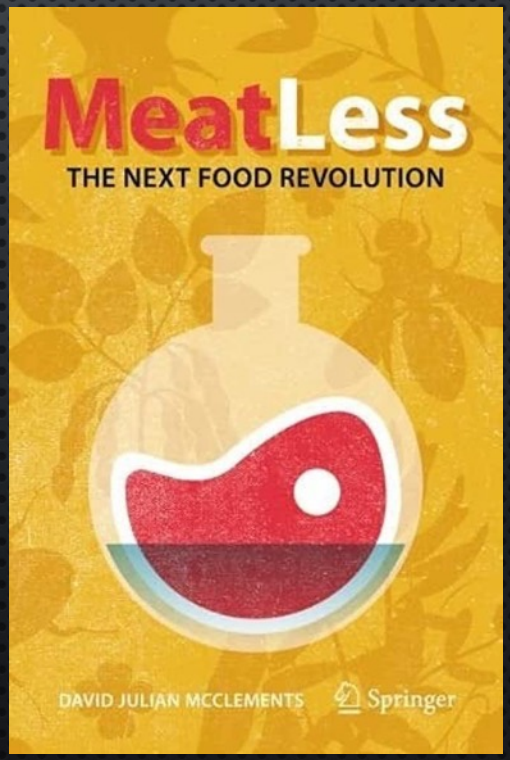
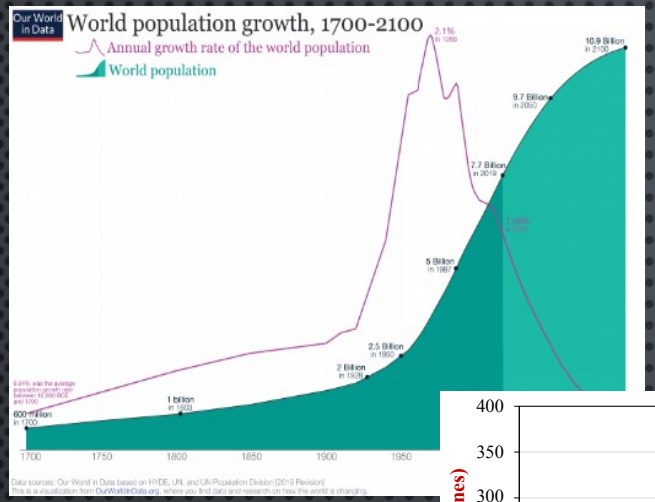
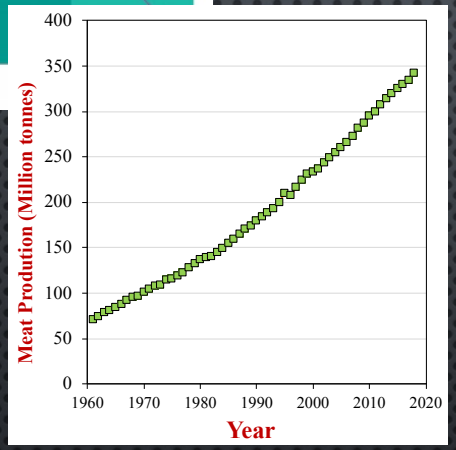
DEPARTMENT OF FOOD SCIENCE

UNIVERSITY OF MASSACHUSETTS







Challenges

- Growing population
- Land use, water use, pollution
- Greenhouse gas production
- Biodiversity loss
- Zoonotic disease
- Antimicrobial resistance

EAT-Lancet Commission Recommendation

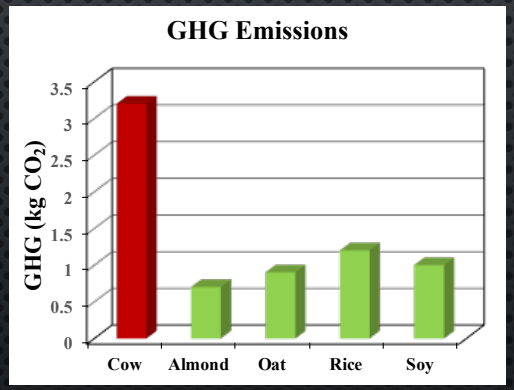
- Defined a healthy and sustainable diet based on planetary boundaries and nutrition knowledge
- **Eat Less animal Foods!**

Willet et al., Food in the Anthropocene: *The EAT–Lancet Commission* on healthy diets from sustainable food systems (2019)

PLANT-BASED FOOD: DRIVERS

Ethical

Environmental



Health

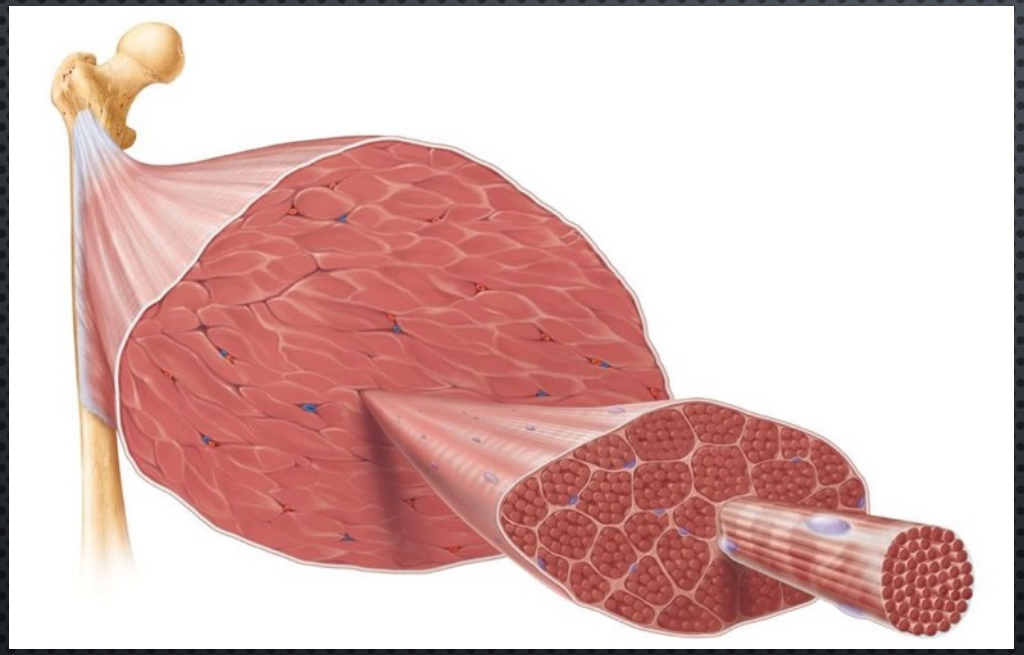
THE RISE OF ALT-PROTEIN FOODS:
MEAT, SEAFOOD EGG, AND DAIRY

$8 billion sales in 2023

(Good Food Institute, USA)

PLANT-BASED MEAT

STRUCTURALLY COMPLEX SOFT SOLIDS



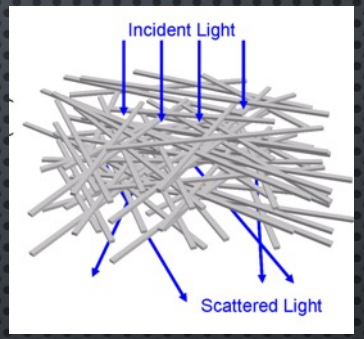
Mimicking Real Meat:
Multisensorial Engineering

Sound
Bubbling & Evaporation

Texture
Small & Large Deformation

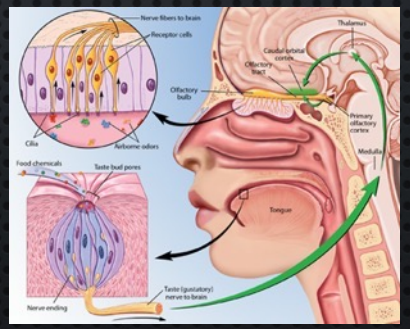
Microstructure
Organization

Appearance
Light Absorption & Scattering



Aroma
Specific Volatile Profile

Mouthfeel
Breakdown/Texture-Time

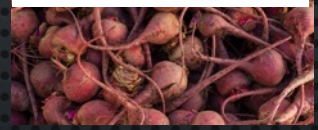


Taste
Specific Tastant Profile

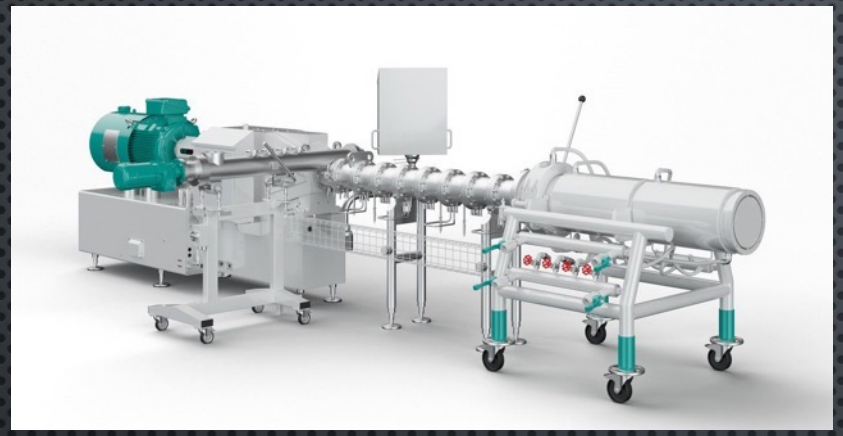
What is the structural basis of deliciousness?

PLANT-BASED MEAT PRODUCTION:
INGREDIENTS

Ingredients



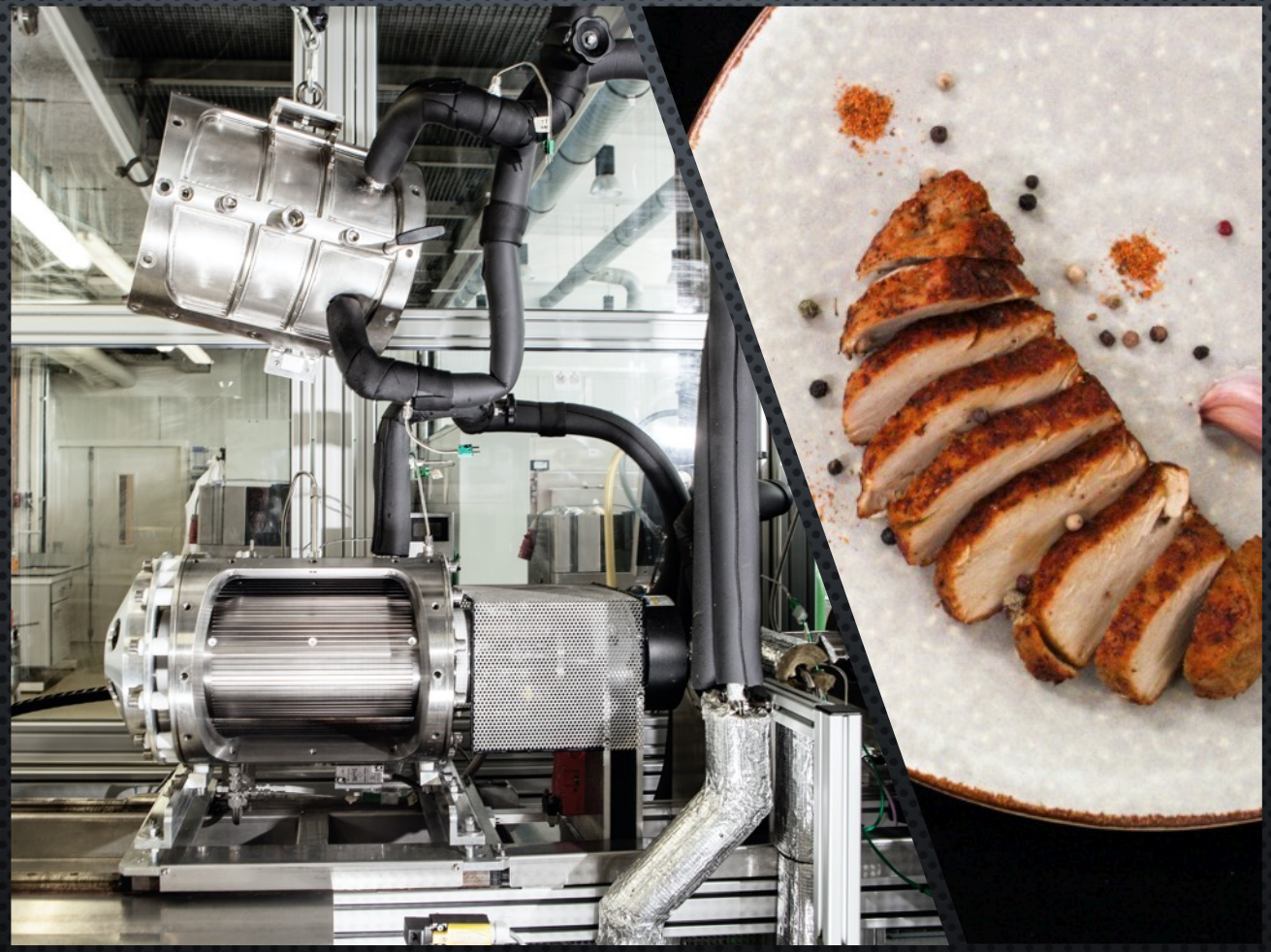
23 Ingredients



PLANT-BASED MEAT PRODUCTION:
EXTRUSION

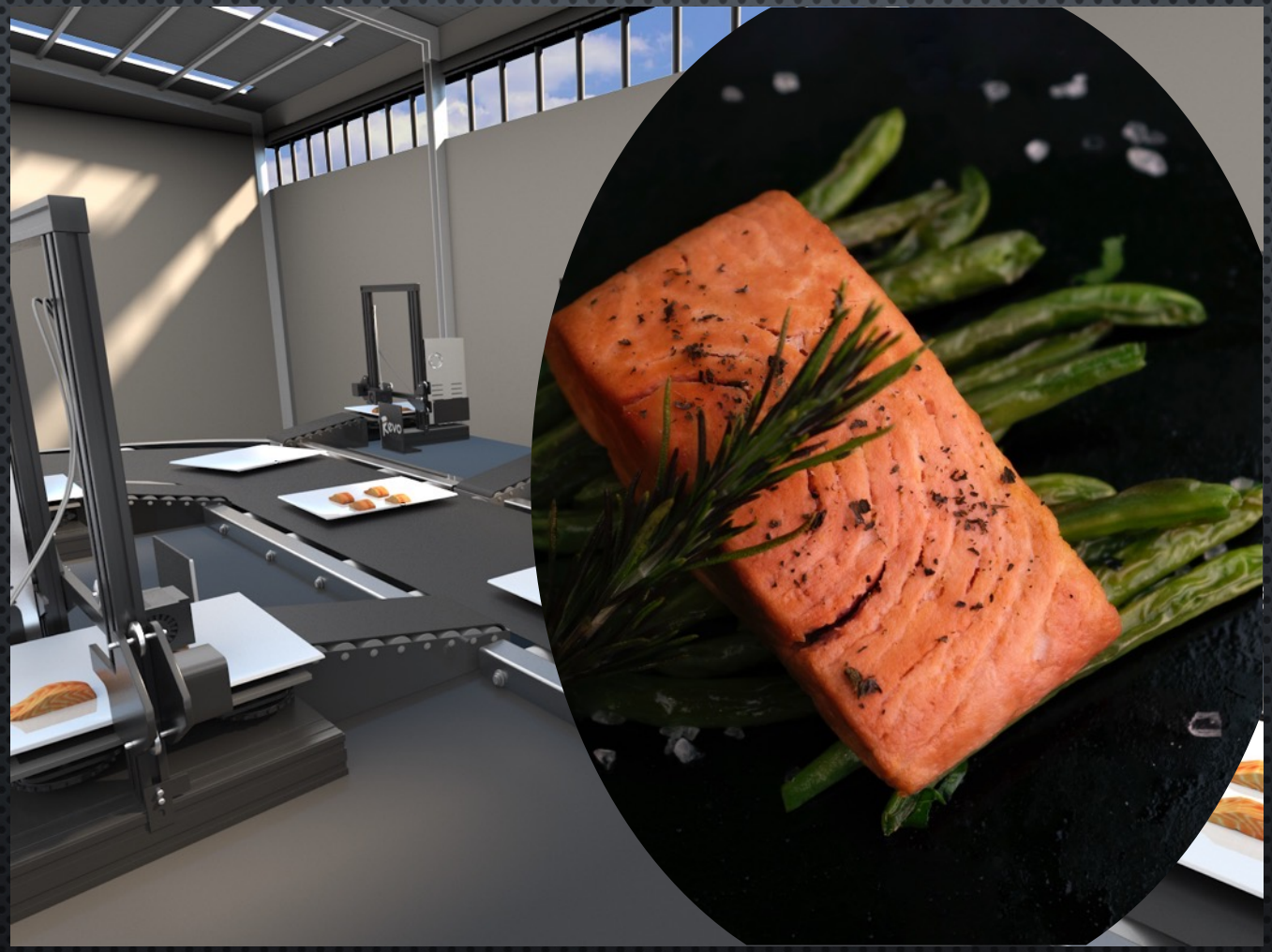
FOOD PROCESSING

PLANT-BASED MEAT PRODUCTION:
SHEAR CELL TECHNOLOGY



Rival Foods (Netherlands)

PLANT-BASED MEAT PRODUCTION:
3D FOOD PRINTING

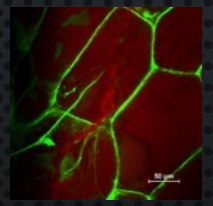
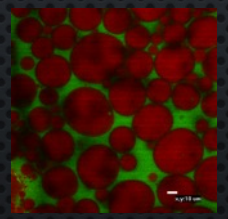


Revo Foods (Austria)

PLANT-BASED MEAT PRODUCTION:
SOFT MATTER PHYSICS

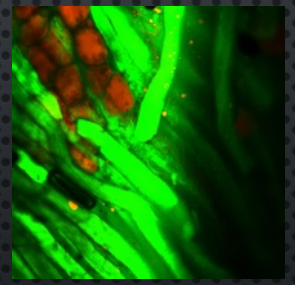
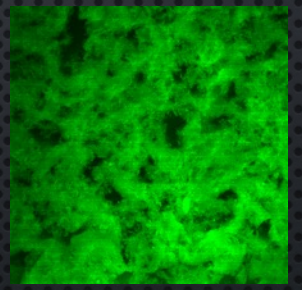
Muscle &
Connective Tissue

Adipose
Tissue

Animal-based

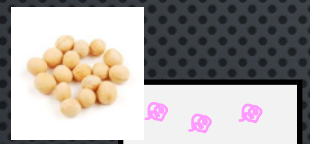
Plant-based

Animal-based

Plant-based


PLANT-BASED MEAT PRODUCTION:
SOFT MATTER PHYSICS



Pea Protein

Heat

Pectin

Combine

Phase Separation

Mix

Structure Formation

Shear & Gel

Fiber Formation

Meat-like Structure

NEXT-GENERATION PLANT-BASED FOODS: DESIGNING FOR HEALTH

Real salmon has about around 20% protein

Nutrition Facts

Serving Size: 1 slices (85g)

Amount Per Serving	
Calories 170	Calories from Fat 41
	% Daily Value*
Total Fat 4.5g	**7%**
Saturated Fat 1g	**5%**
Trans Fat 0g	
Cholesterol 0mg	**0%**
Sodium 610mg	**25%**
Total Carbohydrates 32g	**11%**
Dietary Fiber 9g	**36%**
Sugars 0g	
Protein 0.5g	
Vitamin A	0%
Vitamin C	0%
Calcium	2%
Iron	0%

* Percent Daily Values are based on a 2000 calorie diet.

INGREDIENTS: WATER, OLIVE OIL, KONJAC POWDER, PEA STARCH, POTATO STARCH, PEA PROTEIN, SEA SALT, ORGANIC AGAVE NECTAR, SEAWEED POWDER, FENUGREEK, ALGINATE(FROM SEAWEED), PAPRIKA, CALCIUM HYDROXIDE.

MEAT ANALOGS AND SUBSTITUTES

Meat Analogs

Meat analogs
Sea food analogs
Egg analogs
Dairy analogs

Novel Meat Substitutes

New nutrient-rich food category

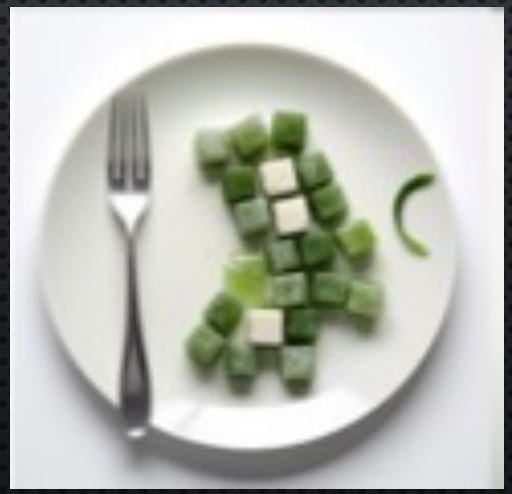
Traditional Meat Substitutes

Tofu
Tempeh
Seitan

NOVEL MEAT SUBSTITUTES
RE-INVENTING FUTURE FOODS



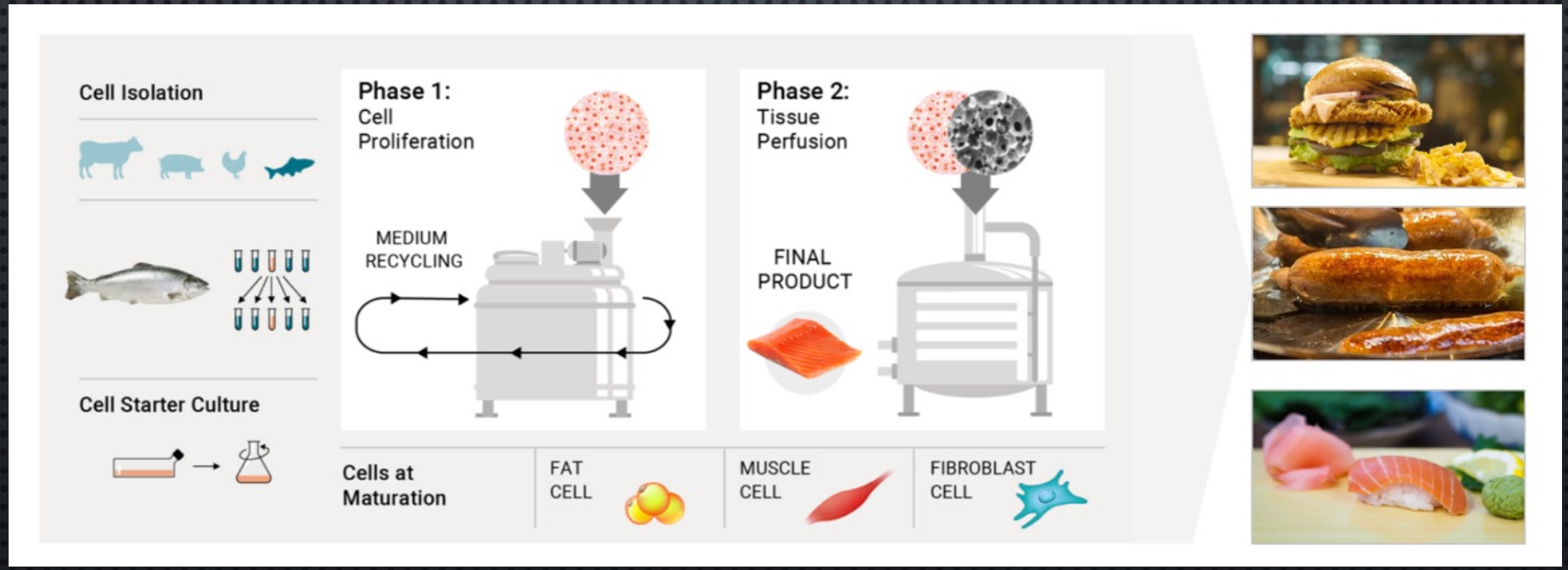





NOVEL MEAT SUBSTITUTES
RE-INVENTING FUTURE FOODS

LAB-GROWN MEAT BURGERS

LAB-GROWN MEAT BURGERS
THE POWER OF BIOTECH



LAB-GROWN MEAT BURGERS
THE POWER OF BIOTECH

UPSIDE Foods

LAB-GROWN MEAT BURGERS
THE POWER OF BIOTECH

BUT WILL IT SUCCEED?

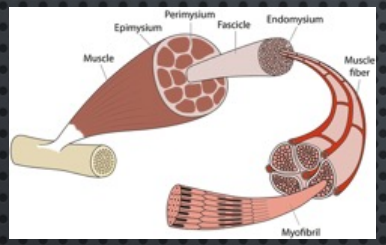
Good Meat: 3% Cultured Chicken

Governor DeSantis Signs Legislation to Keep Lab-Grown Meat Out of Florida
May 1, 2024

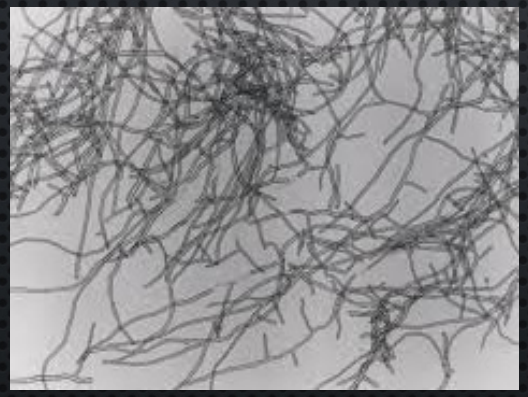
"Lab-grown meat is a disgraceful attempt to undermine our proud traditions and prosperity, and is in direct opposition to authentic agriculture"

MICROBE BURGERS?

MICROBE BURGERS:
MICRO-FUNGUS PROTEIN



Fibrous meat structure



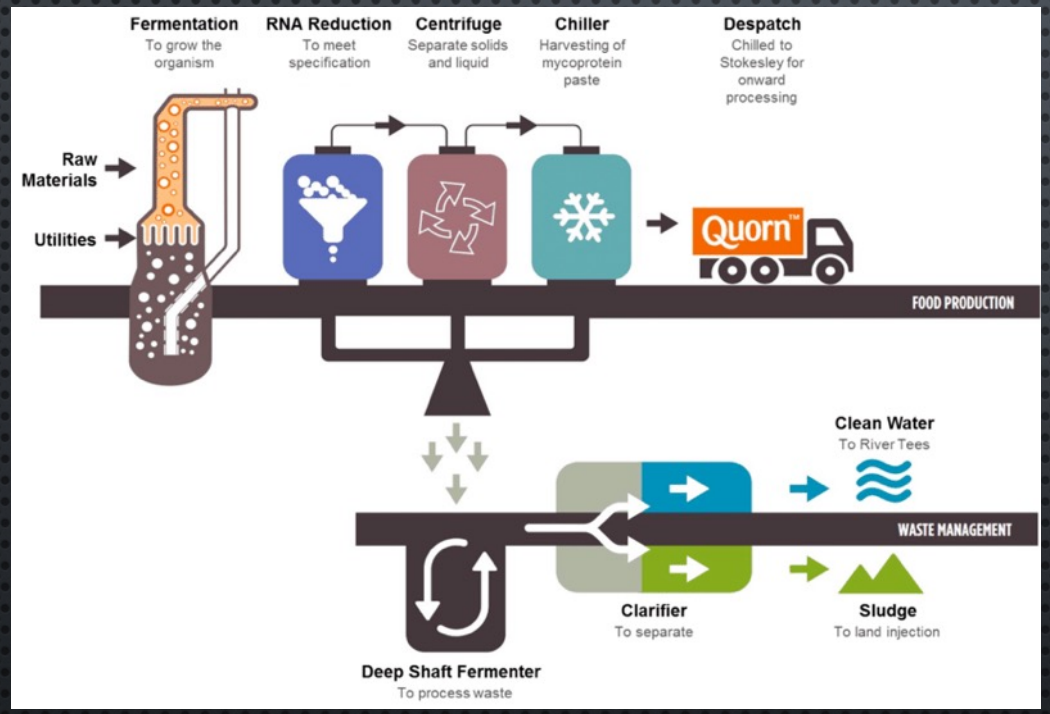
Fusarium venenatum

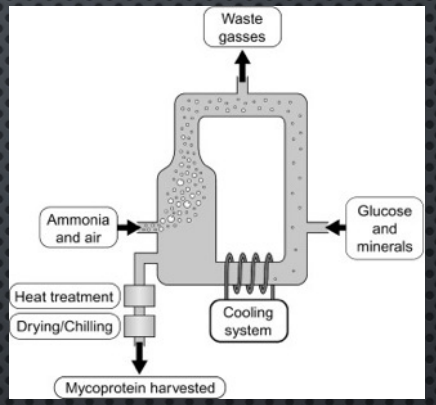
Fusarium venenatum has a filamentous structure that can mimic a lot of the textural & mouthfeel properties of meat products

MICROBE BURGERS
QUORN TOUR

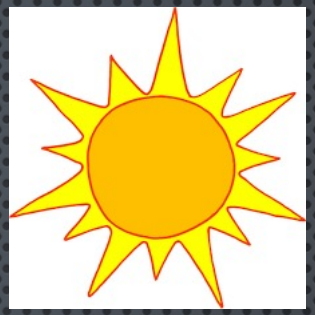
The House I Grew Up In

CREATING SUSTAINABLE MEAT SUBSTITUTES: MICROBE BURGERS





MICROBE BURGERS: BACTERIAL PROTEIN



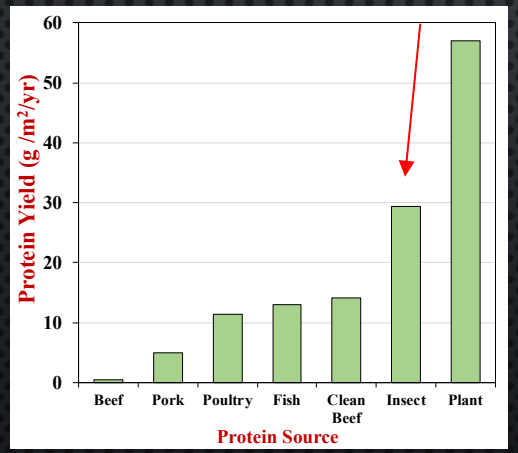
SOLAR FOODS
Finland

Using bacteria to turn sunlight, air, water and nutrients into an edible protein product

MICROBE BURGERS:
FOOD FROM AIR

BUG BURGERS:
INSECT-BASED FOODS

Meal Worms



Insects are already widely consumed around the world (> 2 billion people) but growing interest in Western countries due to sustainability issues

"DELICIOUS" BUG RECIPES

Mescal Worm Tacos

Deep-Fried Tarantulas

Garlicky Grasshopper Mix

THE YUCK FACTOR!

Lightly Fried Dragonflies

“DELICIOUS” MEAT RECIPES

THE YUCK FACTOR!

CULTURAL BIAS?

Ocean Cockroach?

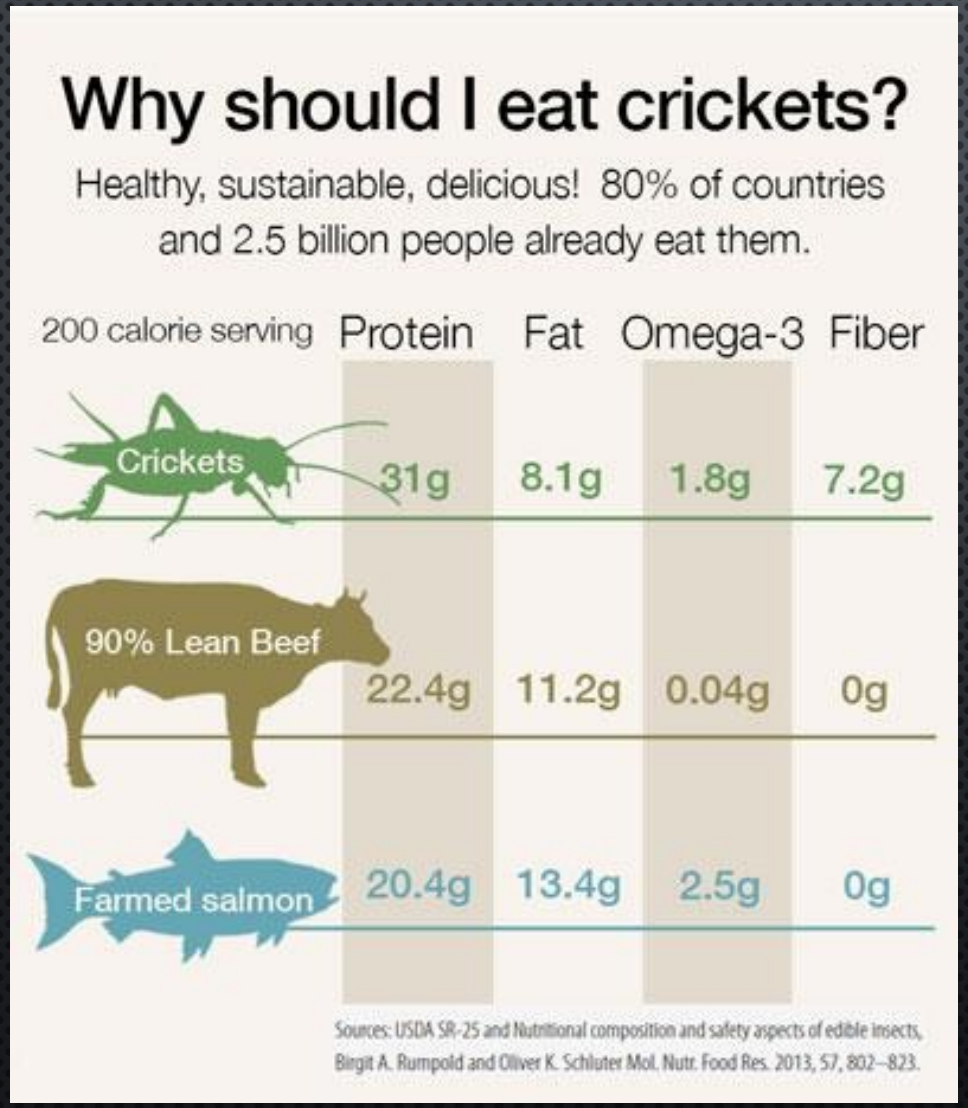
Giant River Worm?

Sea Locust?

WTF?

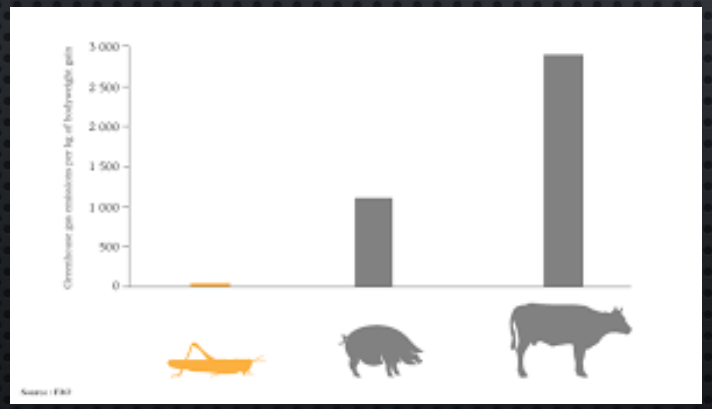
Many people in the West find eating insects to be highly undesirable, but we also felt the same way about lobsters until fairly recently

INSECT FARMING: HEALTH



Rich in healthy lipids, proteins, fibers, vitamins & minerals

INSECT FARMING: SUSTAINABILITY



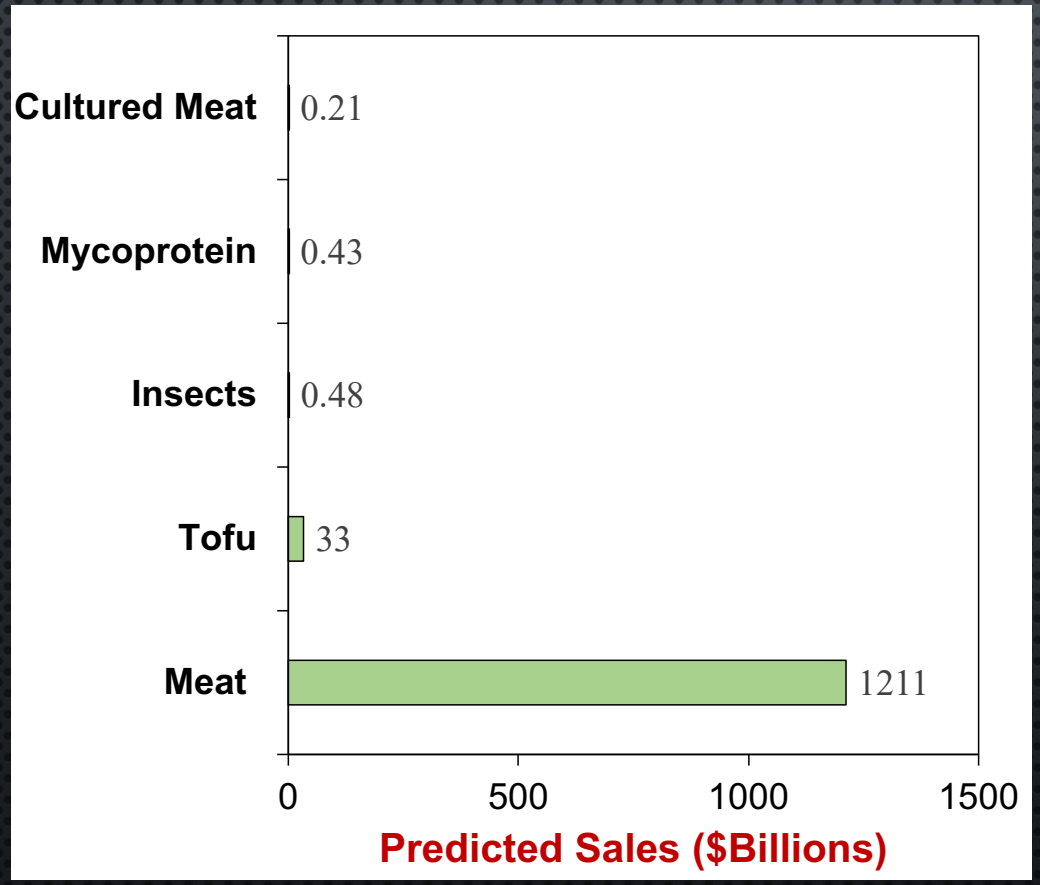
Less GHG emissions, pollution, water use and land use

Better Feed Conversion

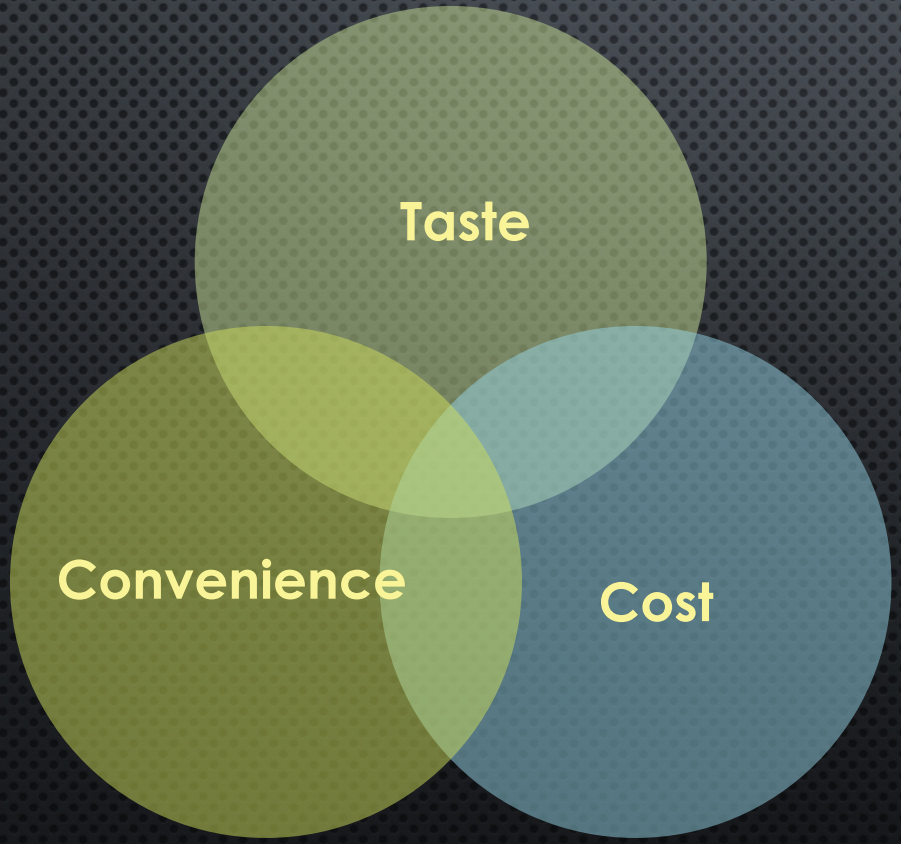
BUG BURGERS
COMING TO A SUPERMARKET NEAR YOU

Christian Bartsch - founder of Essento

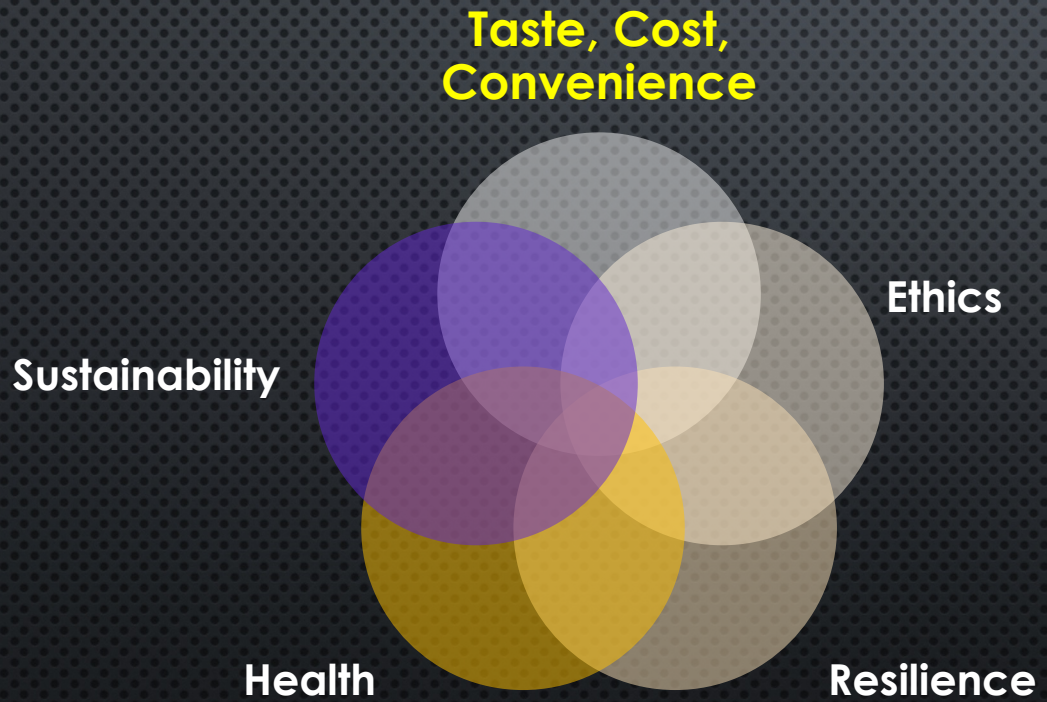
A SUSTAINABLE FOOD FUTURE?
A LONG ROAD AHEAD!

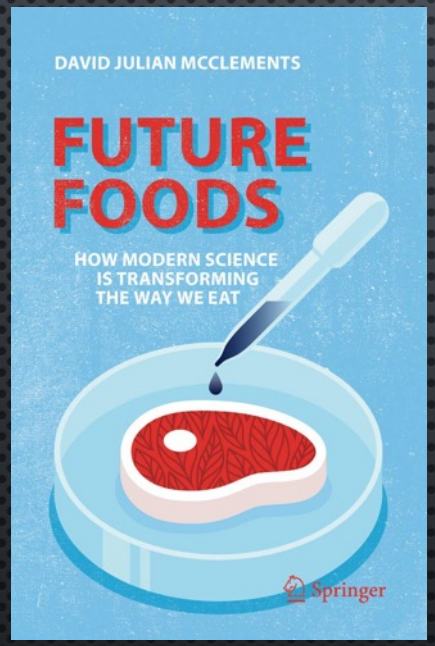


FOOD SCIENCE & ENGINEERING:
THE OLD PARADIGM

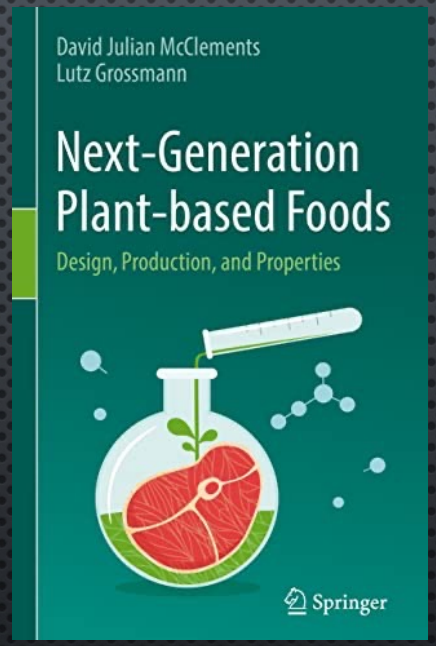


FOOD SCIENCE & ENGINEERING:
THE NEW PARADIGM

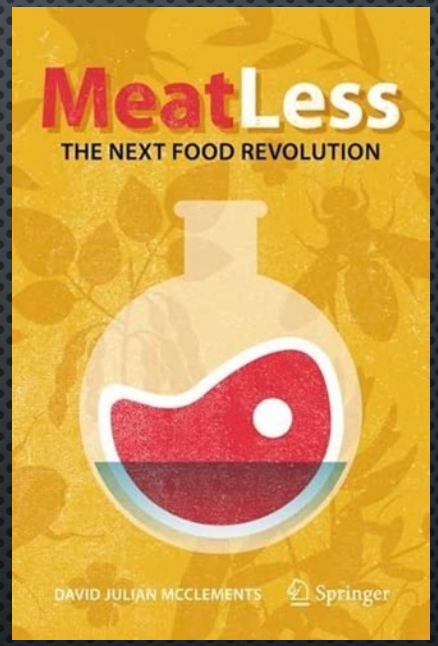




2019



2022



2023

ACKNOWLEDGEMENTS

NSF

UMASS AMHERST

NASA

USDA

THE GOOD FOOD INSTITUTE