

The future of protein: Cultured meat?



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@MarkPost6

KIVI, 2018







GREENHOUSE GASES



World Average Virtual Water Content



V.S.



15,500



Beef

4,850



Pork

3,900



Chicken

2,300



Rice

1,800



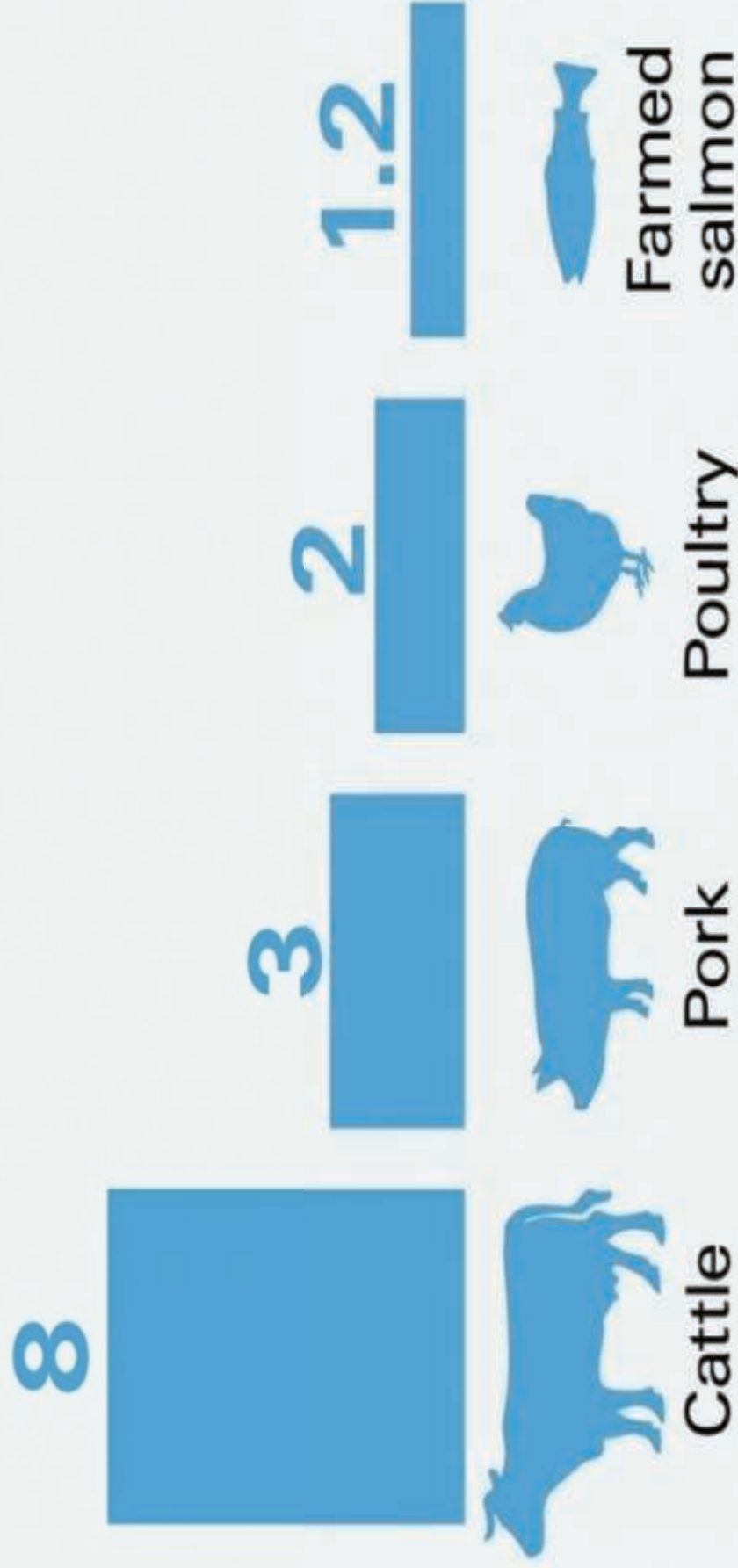
Soya

1,300



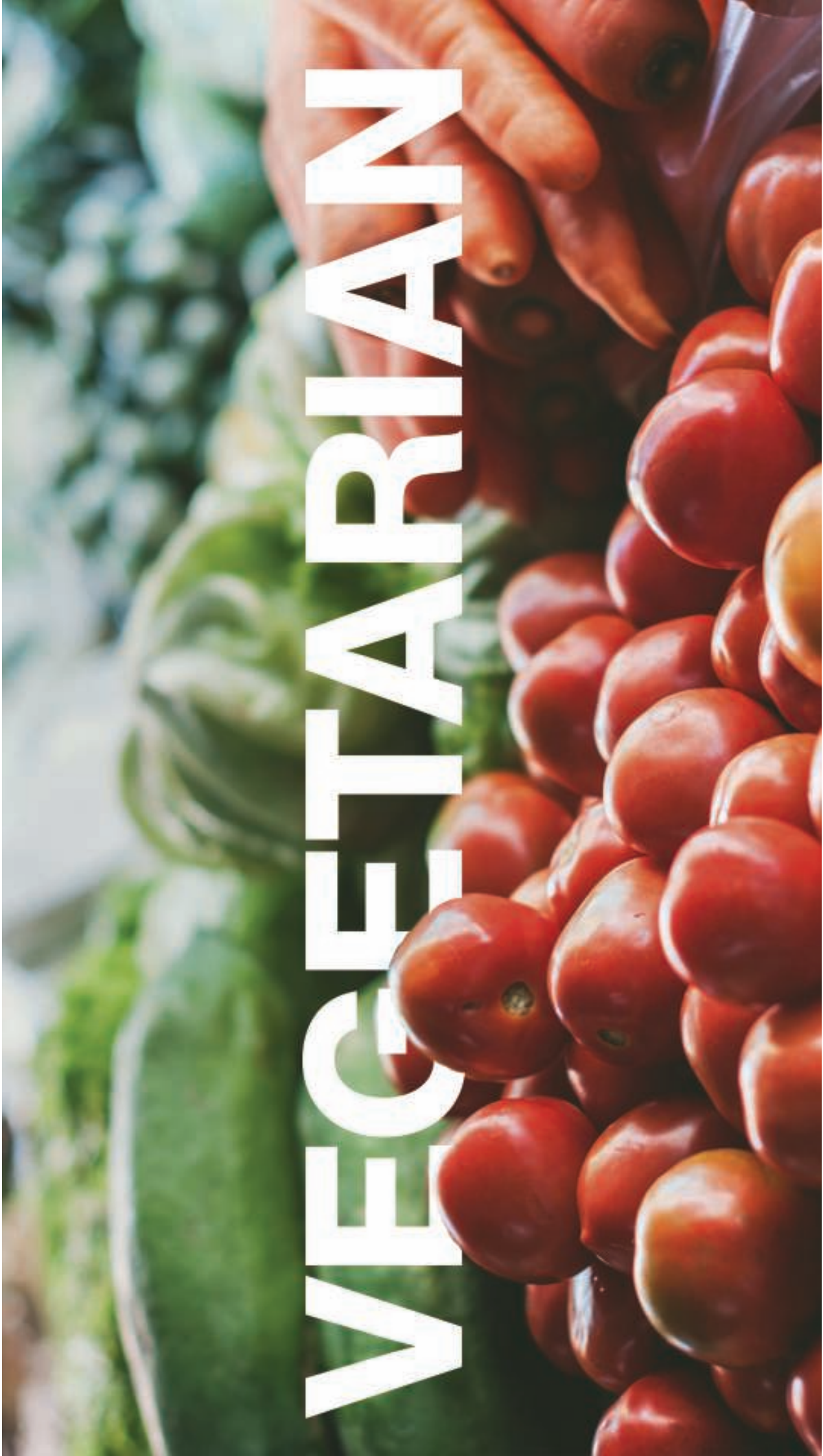
Wheat

FEED CONVERSION RATIO OF SELECTED MEAT AND FISH WORLDWIDE

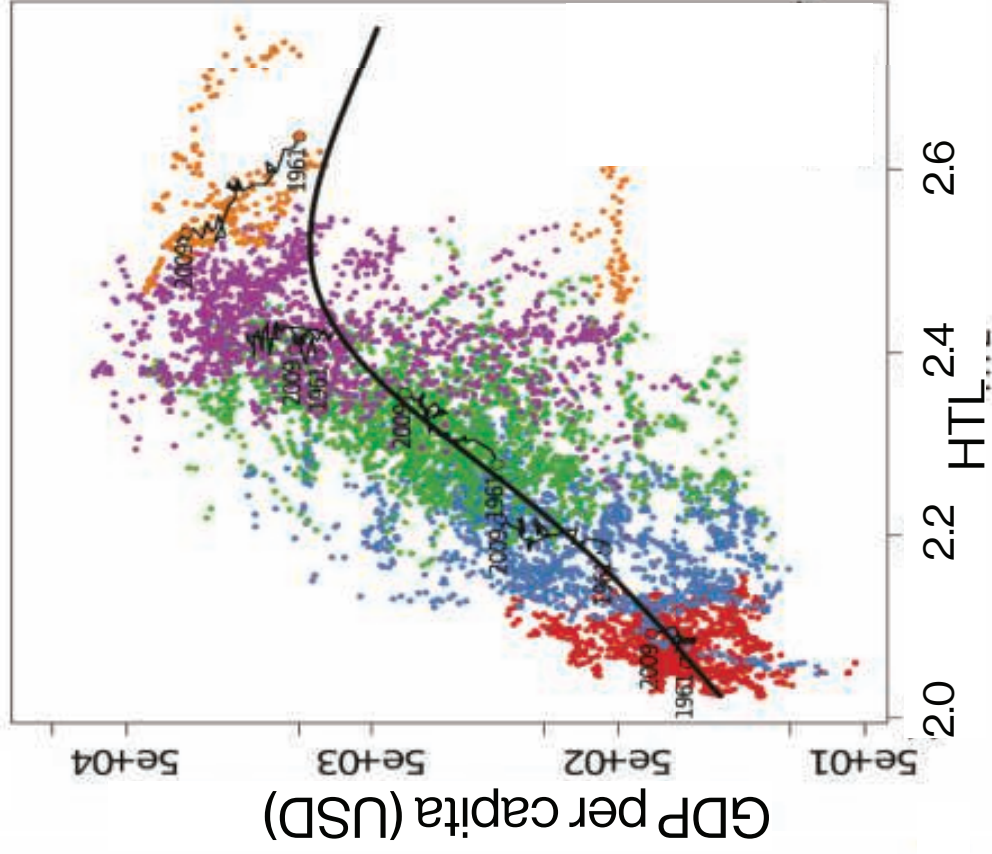
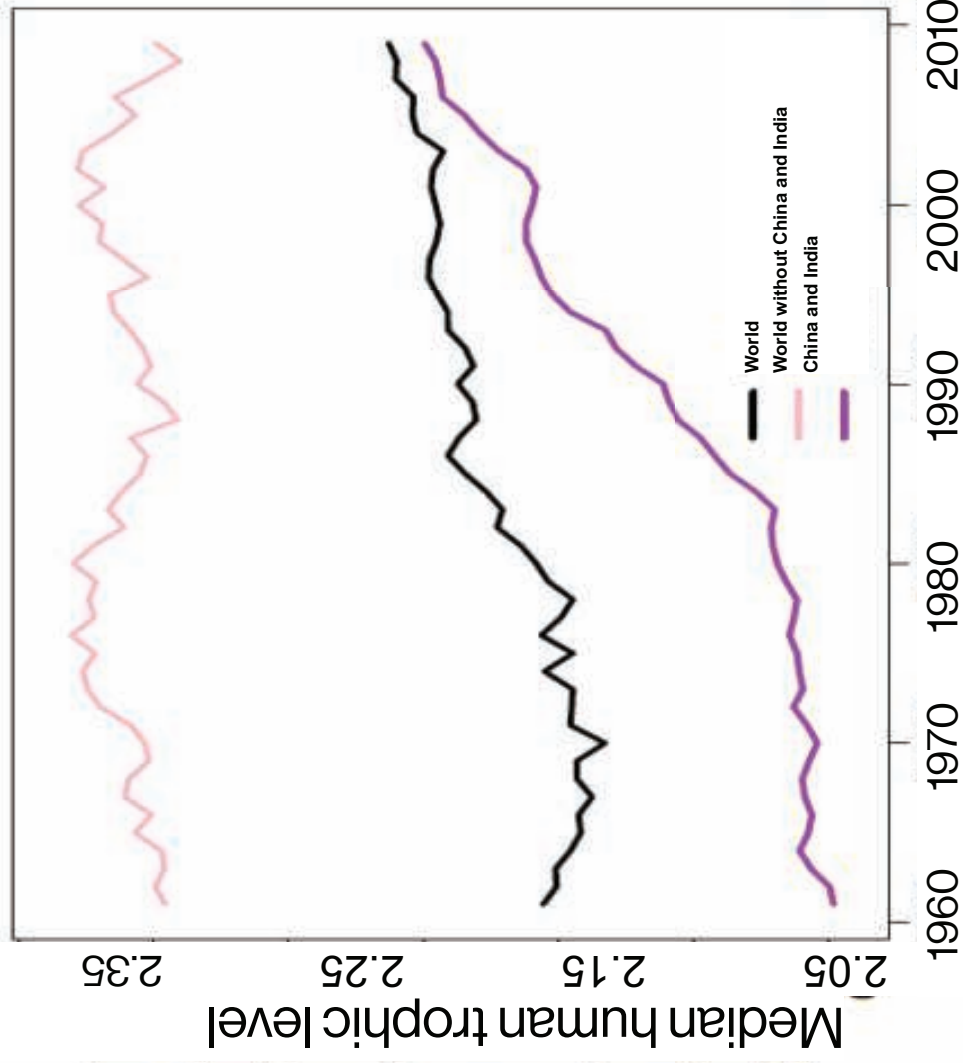




VEGETARIAN



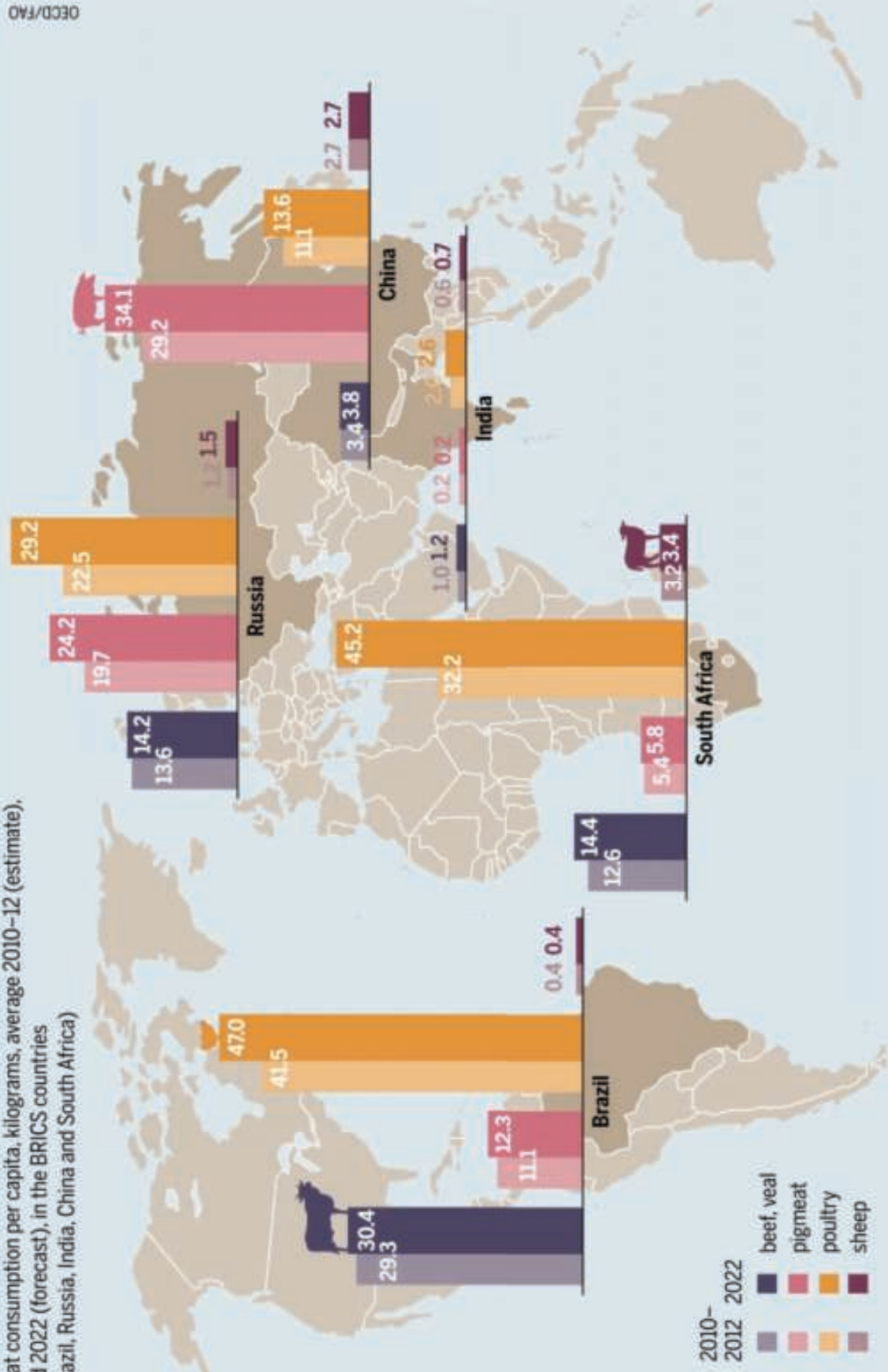
Human trophic level



Bonhommeau et al, PNAS, Dec 2013

Demand in the developing world is rising steeply

Meat consumption per capita, kilograms, average 2010–12 (estimate), and 2022 (forecast), in the BRICS countries (Brazil, Russia, India, China and South Africa)



MEAT



MARKET BOWNS
Roosteck milanese
879,00€

MARKET BOWNS
Cote
820,00€

MARKET BOWNS
Entrecote
820,00€

MARKET BOWNS
FILET
560,00€



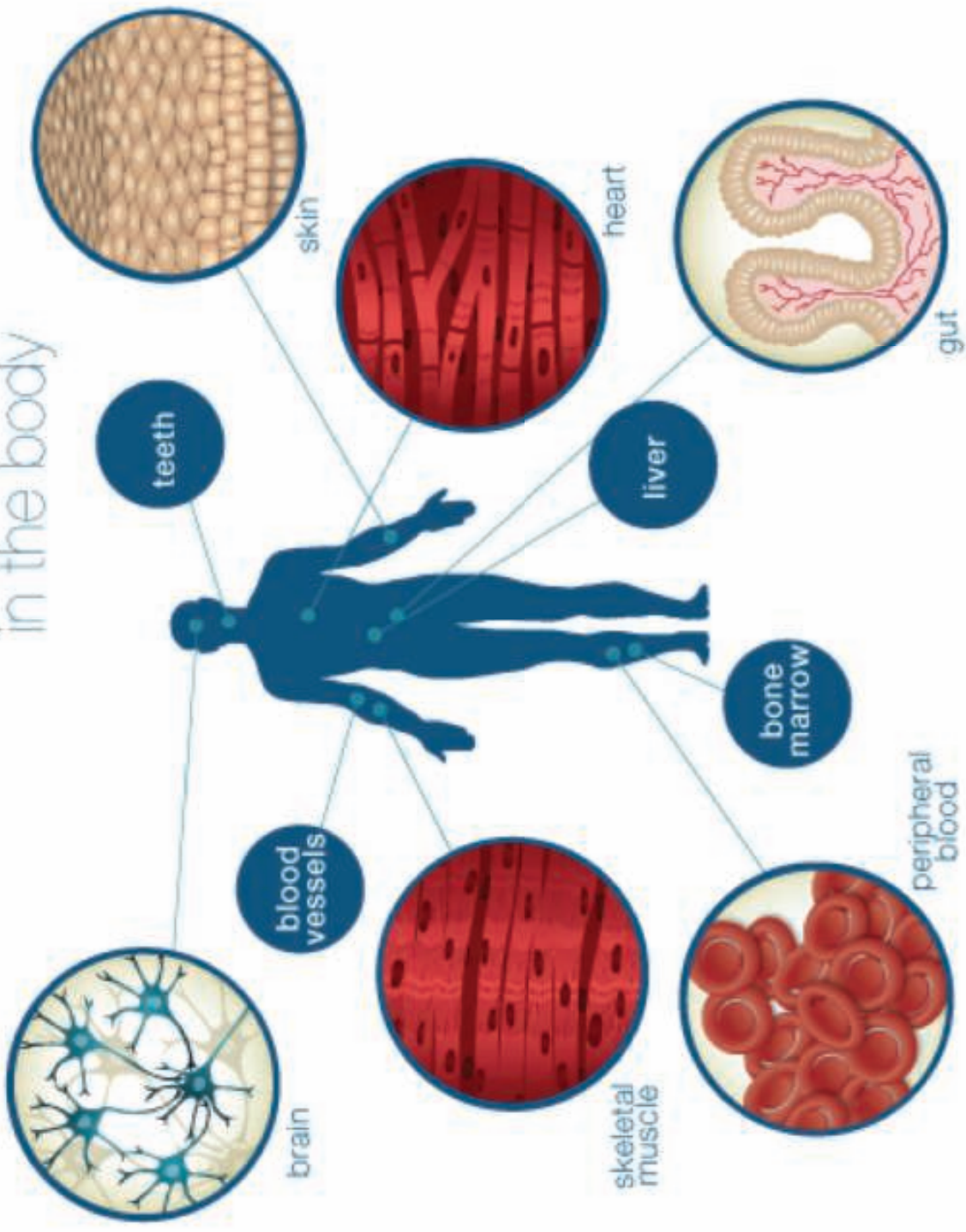
Churchill, 1932

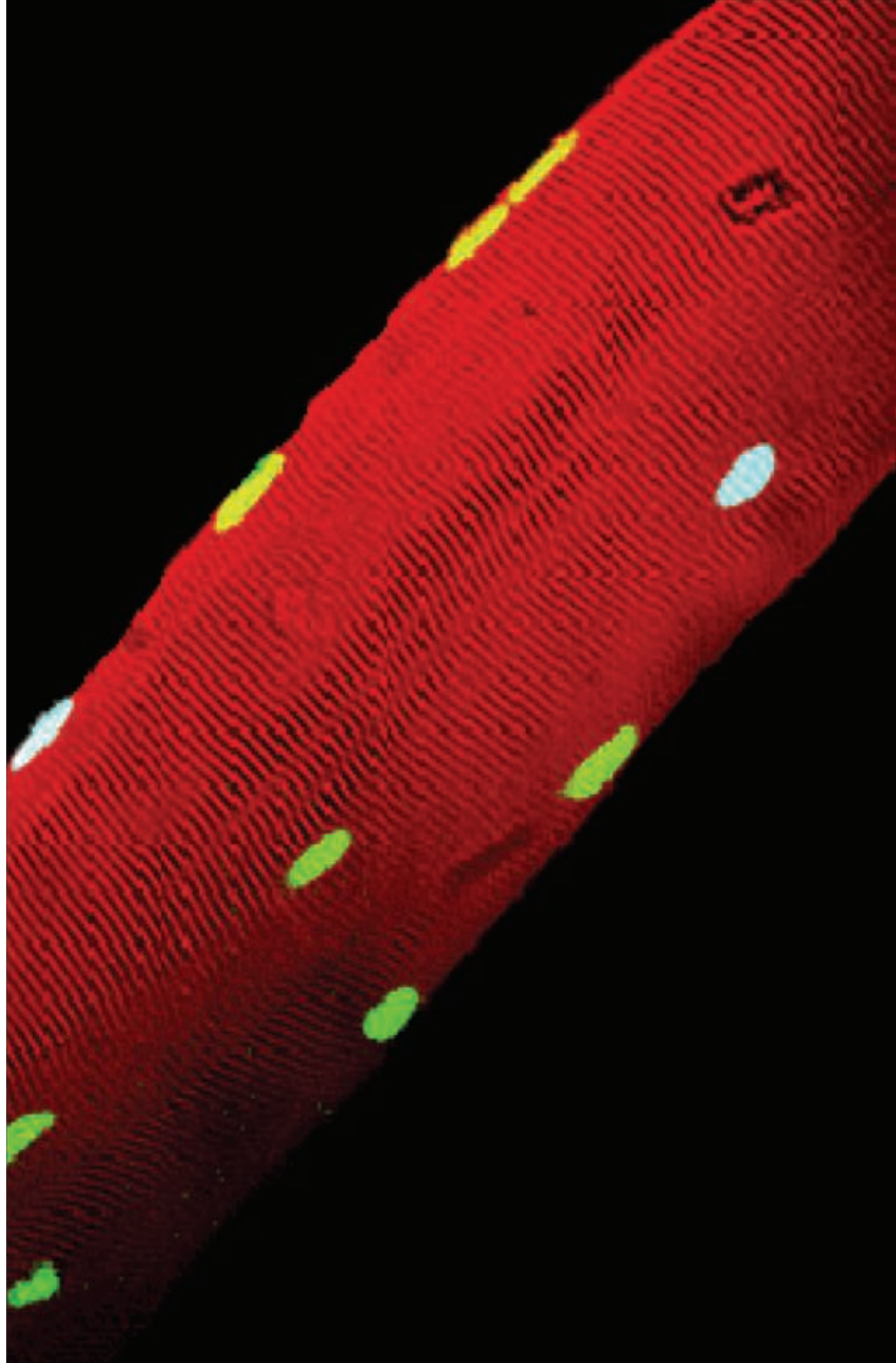


Alexis Carrell & Charles Lindbergh, 1932

Locations of Somatic Stem Cells

in the body

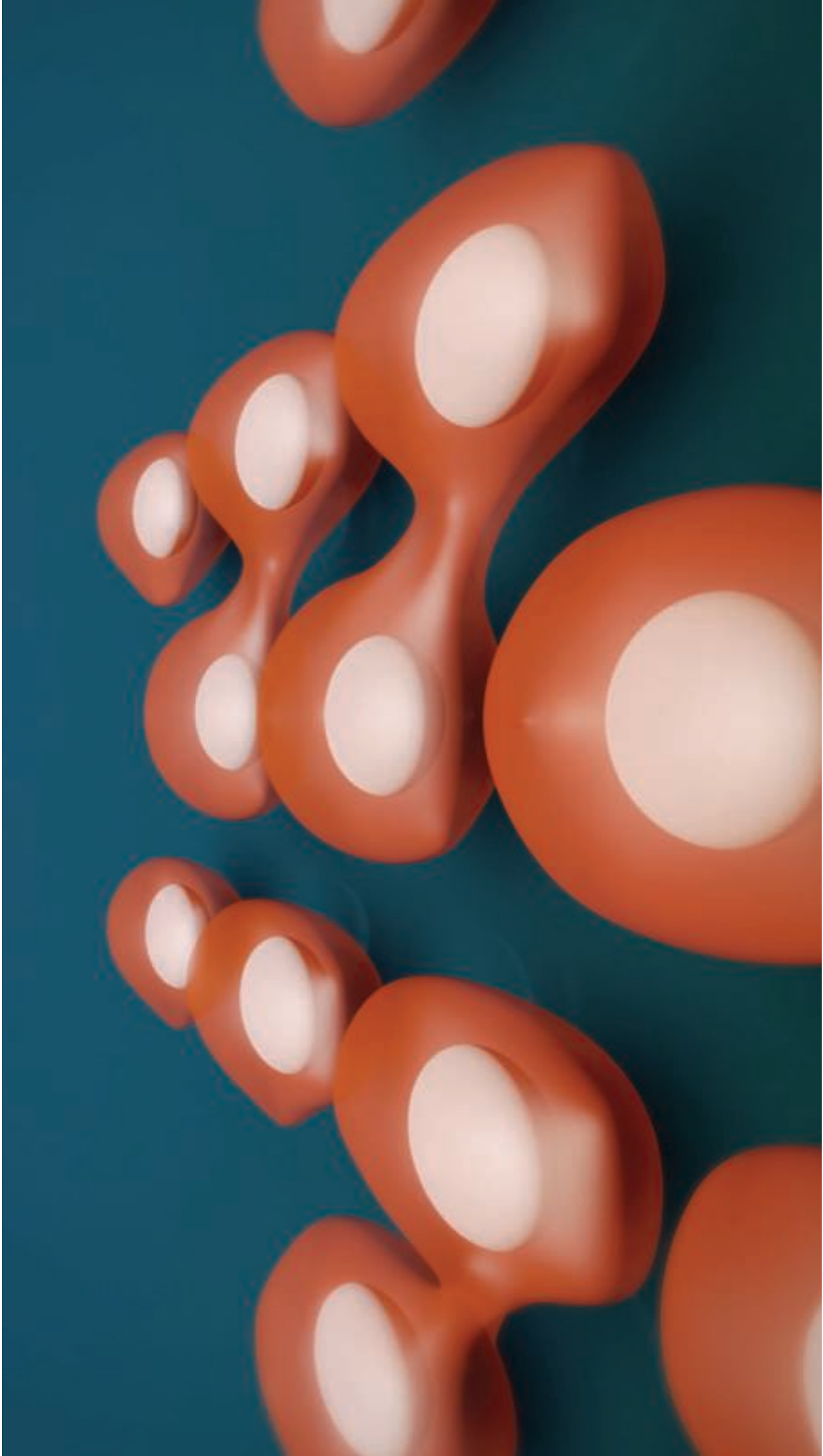








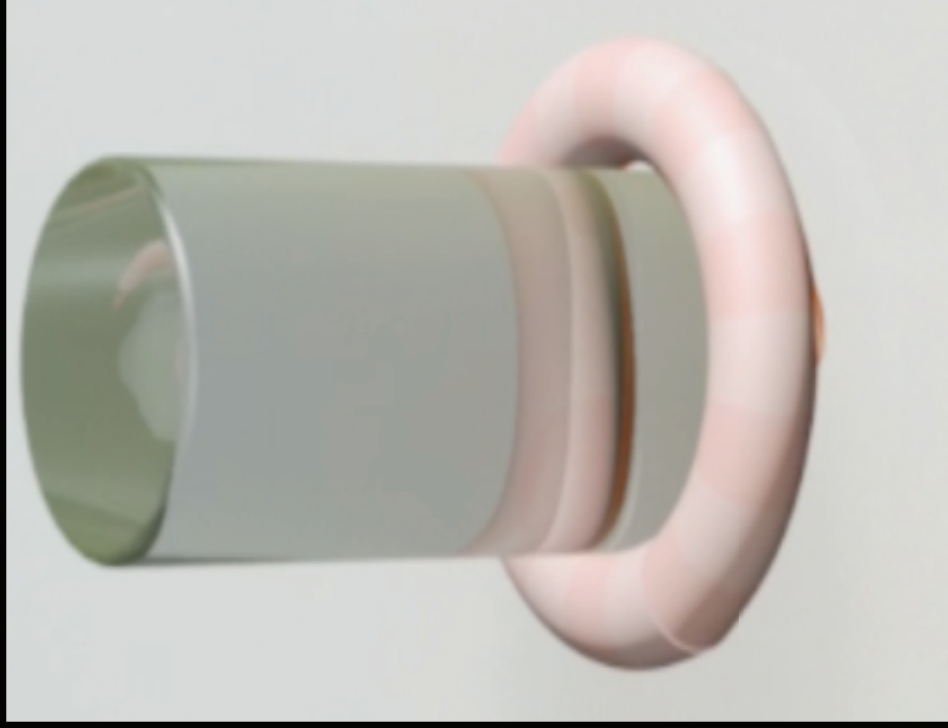
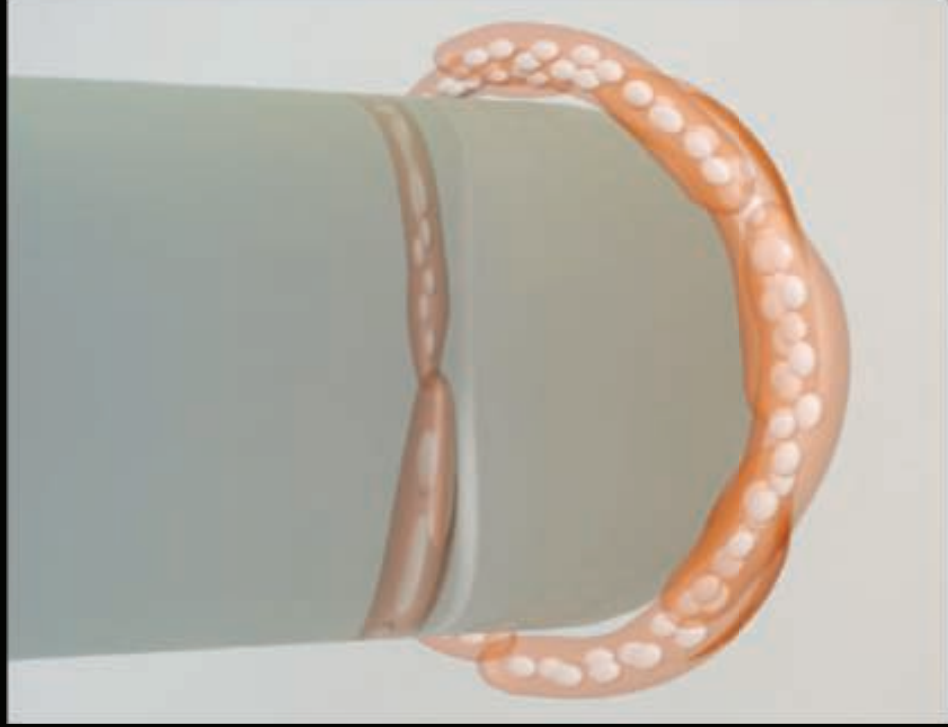
B I O P S Y



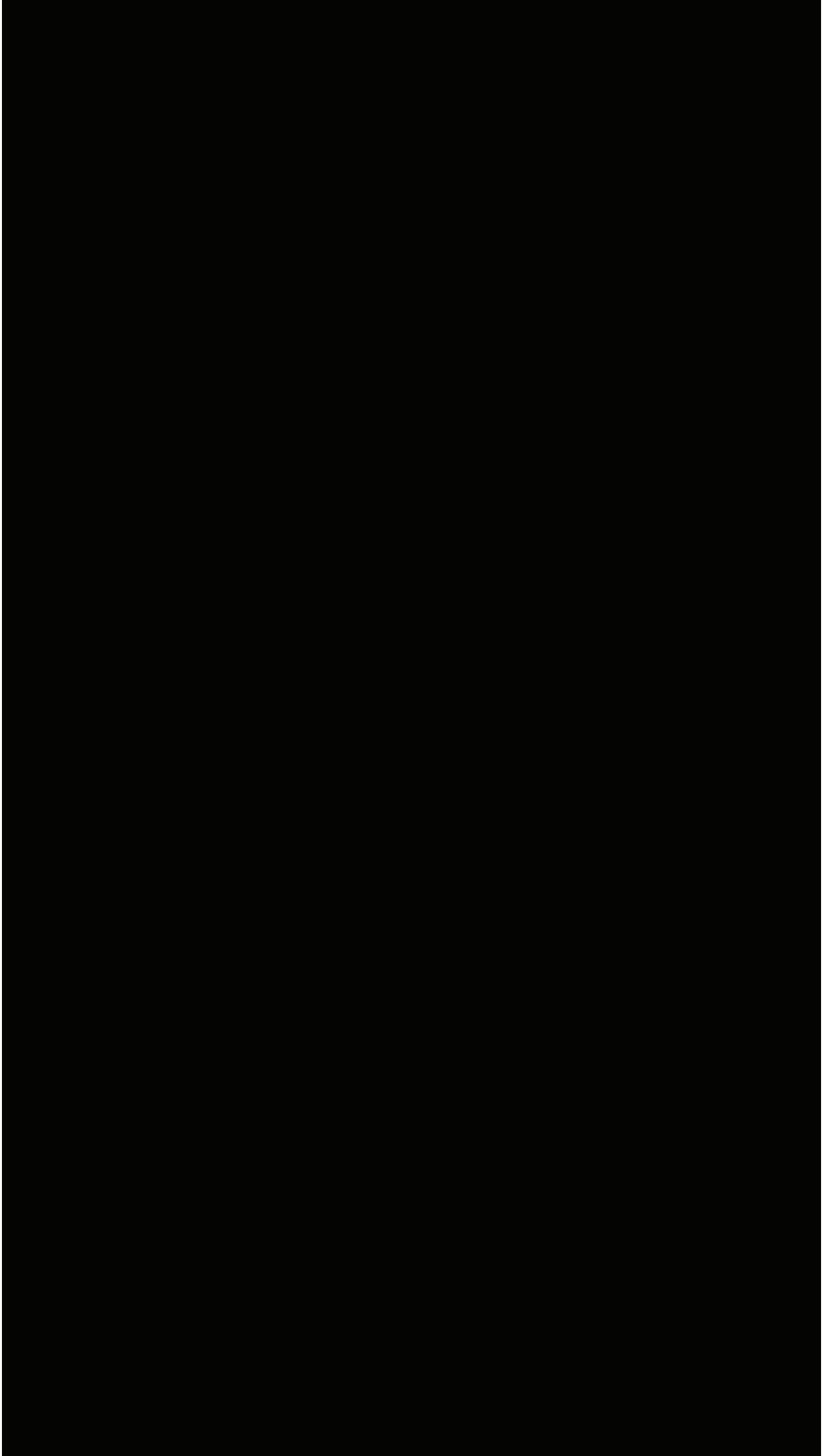
MYOTUBE



3 weeks







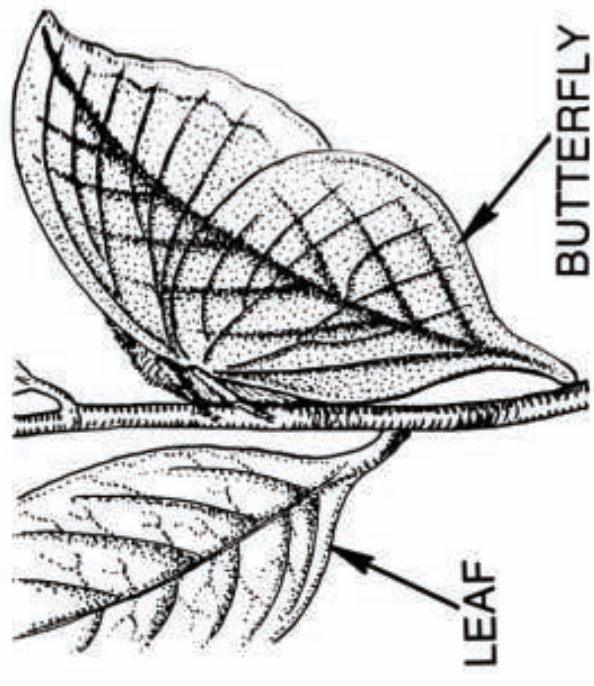
Efficiency



Sustainability



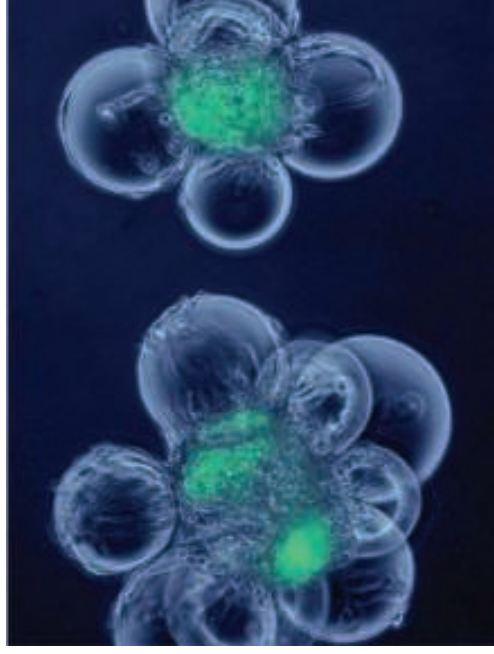
Mimicry



EFFICIENCY



culture
conditions



cell
selection

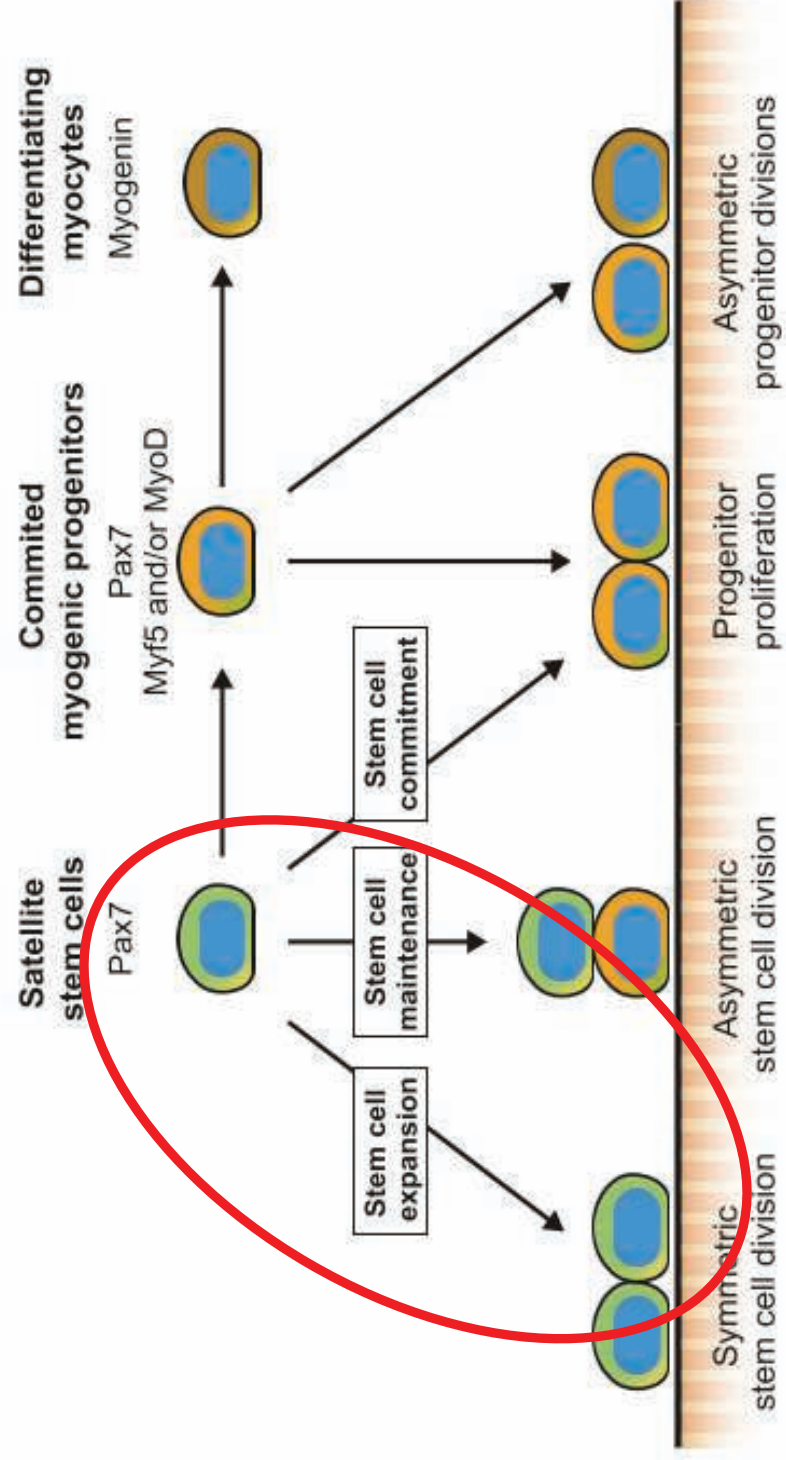


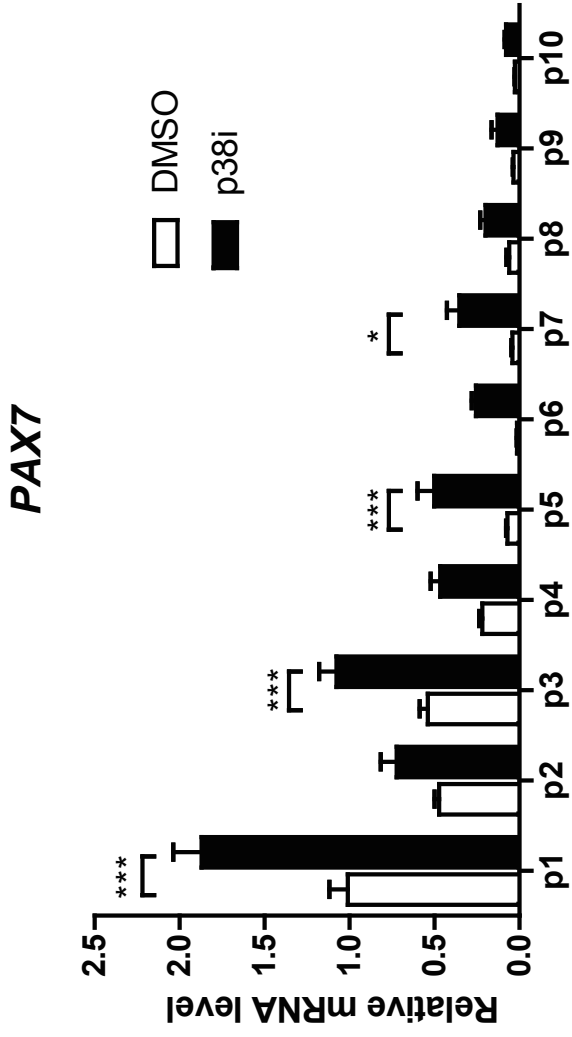
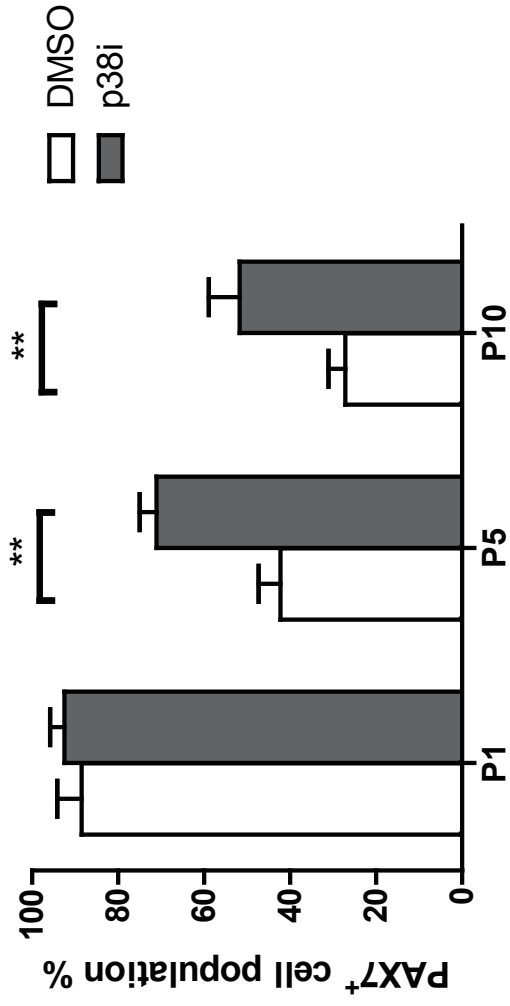
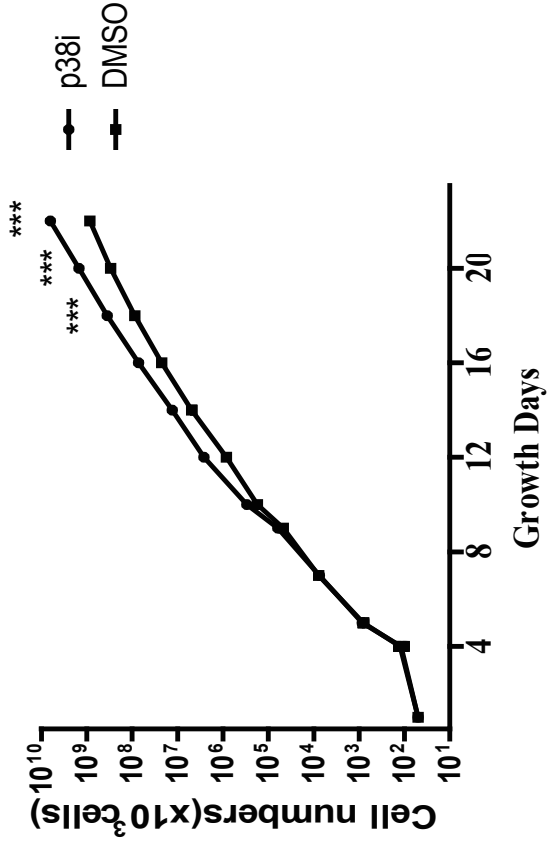
scale up



Leonard Hayflick (1928-)

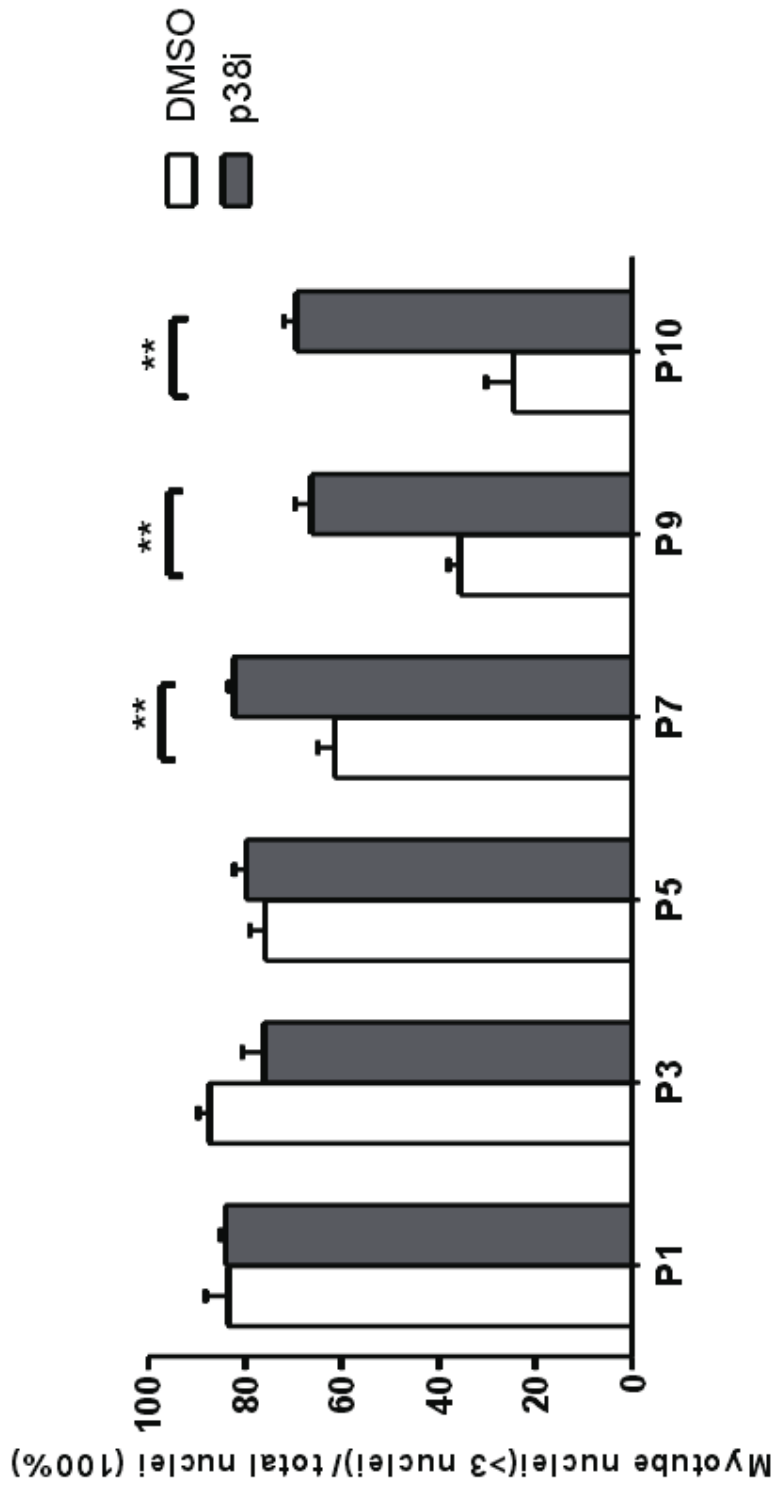
How to keep the stemness of bovine satellite cells?



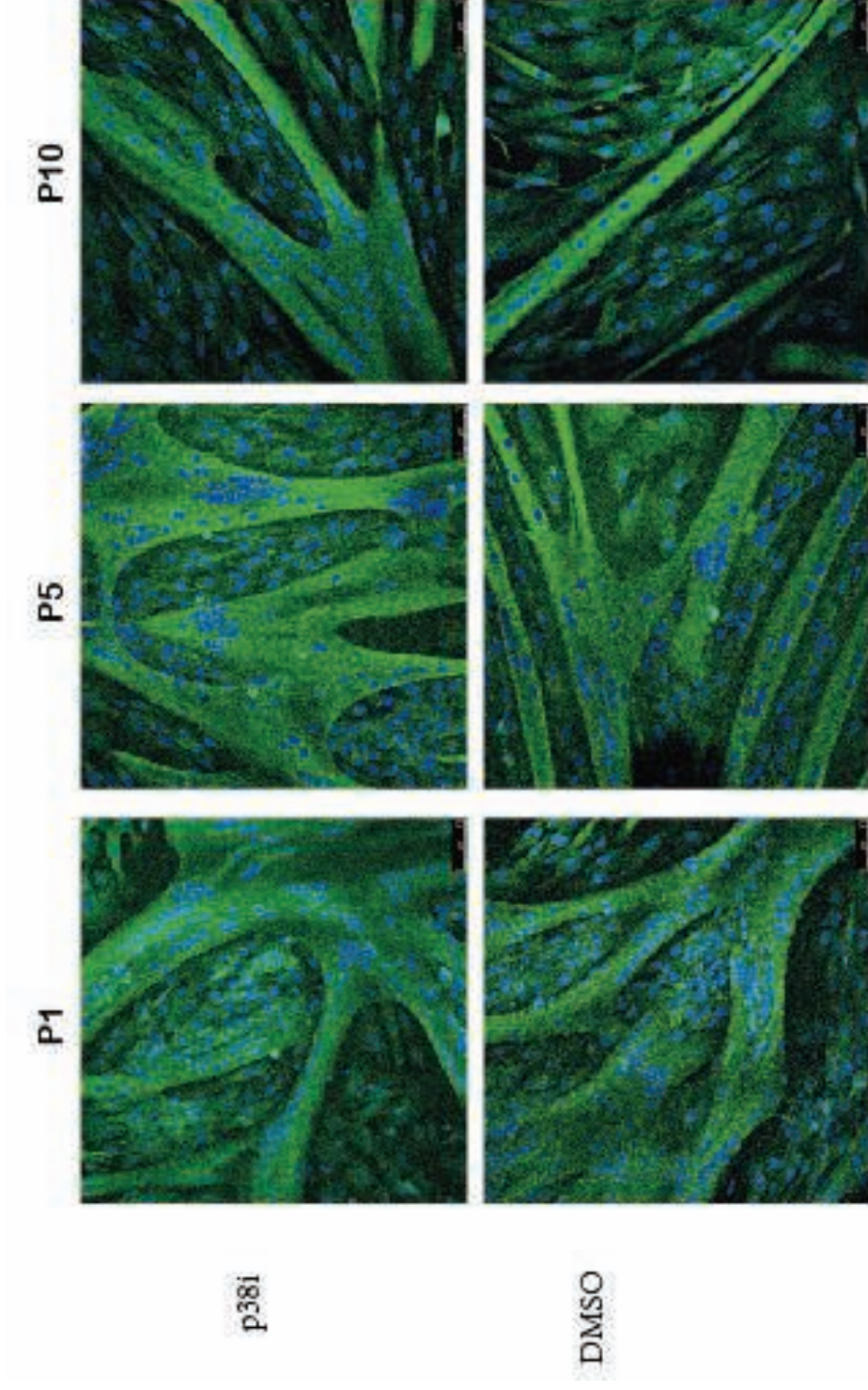
C**d****a**

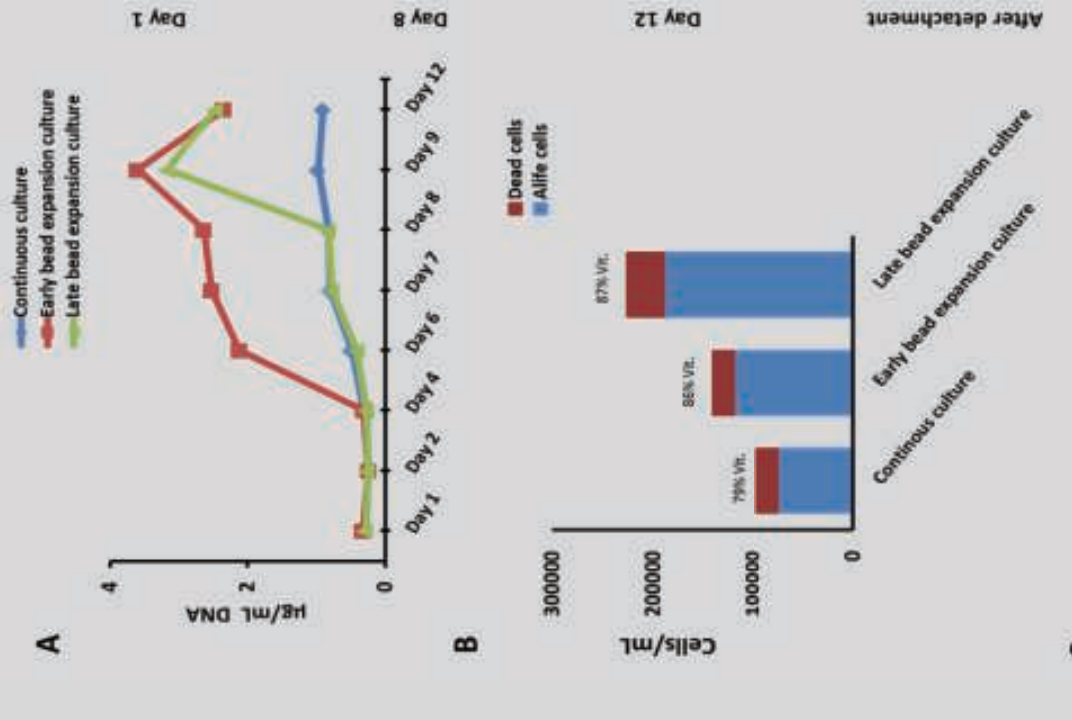
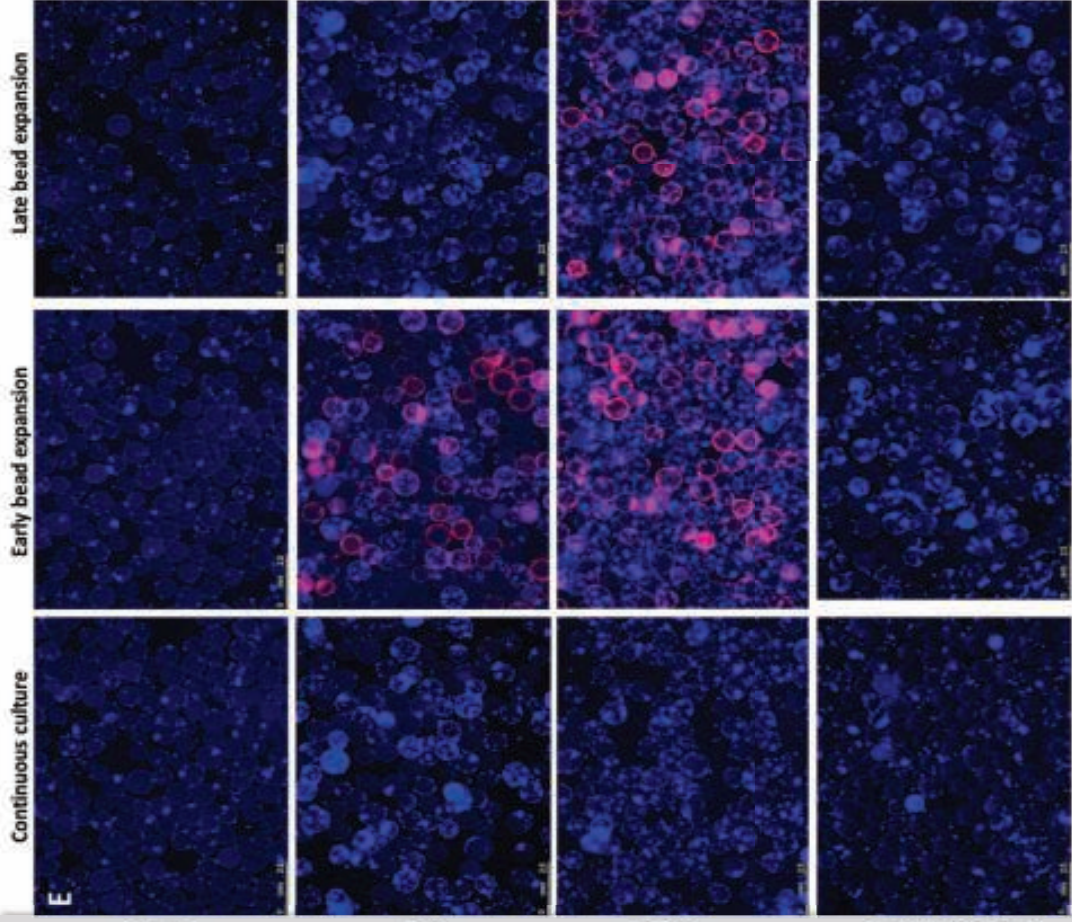
Ding et al, Sci Rep, in
press

Long-term p38 inhibition maintains differentiation abilities

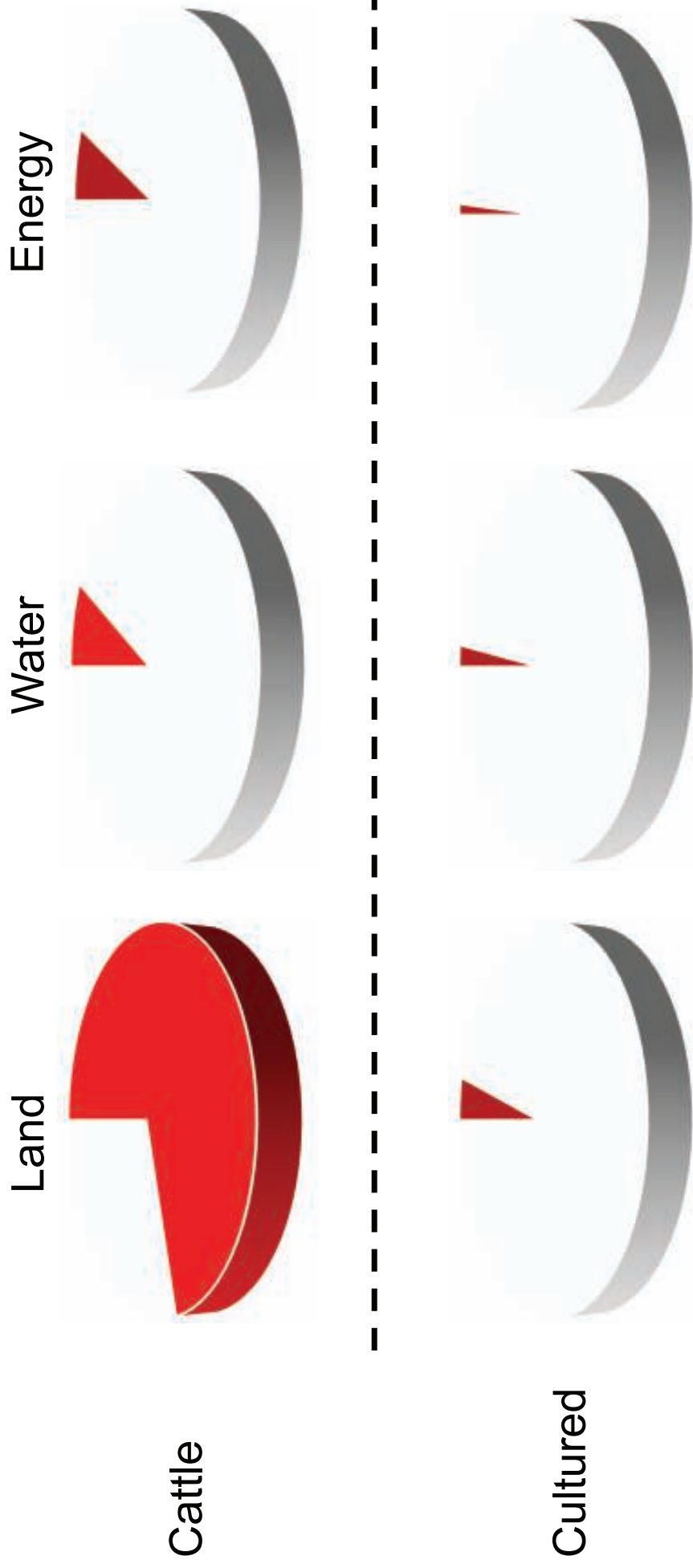


Long-term p38 inhibition maintains differentiation abilities



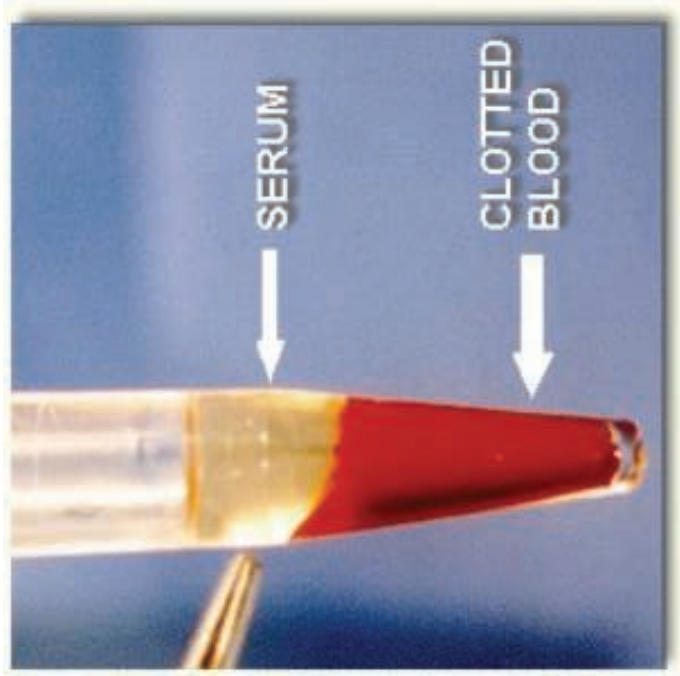


Life cycle analysis

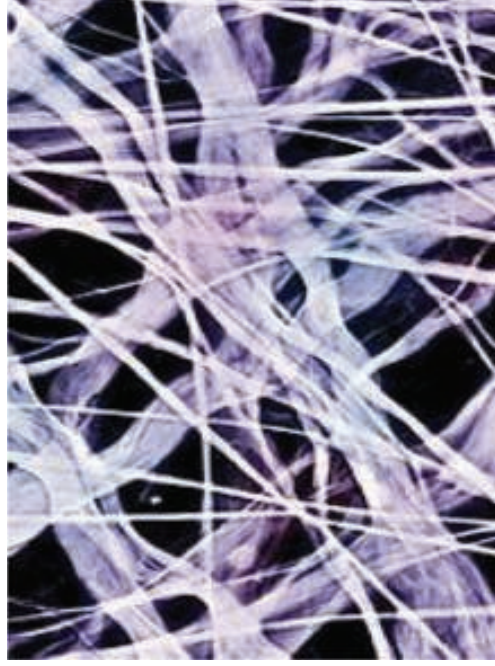


Percent of earth resources dedicated to meat production

SUSTAINABILITY



serum

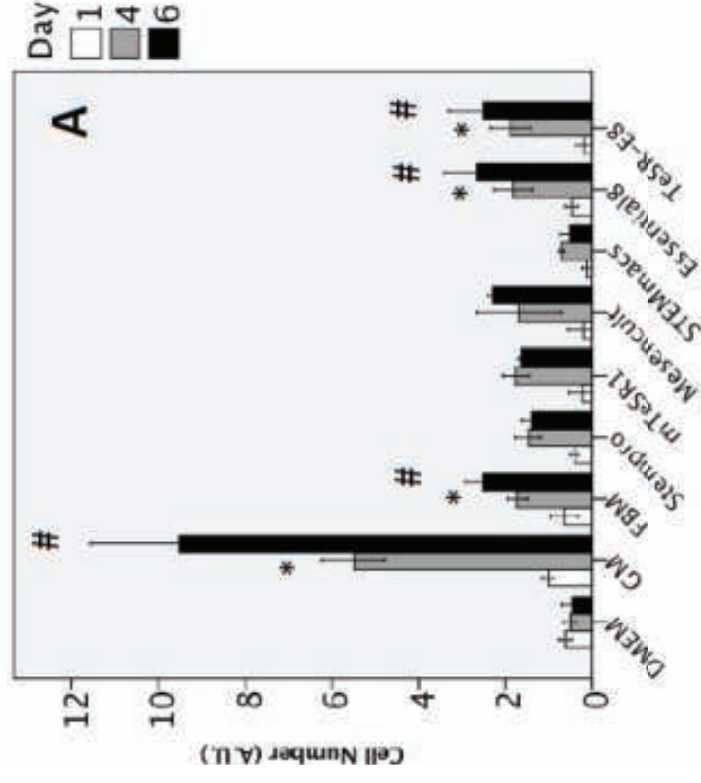
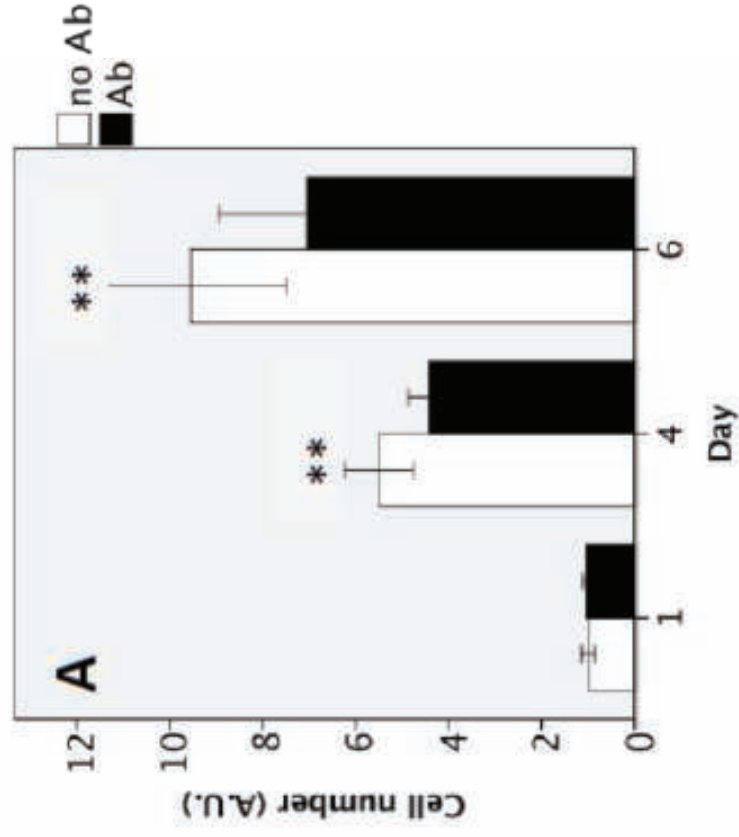


collagen



recycle

No serum, no antibiotics



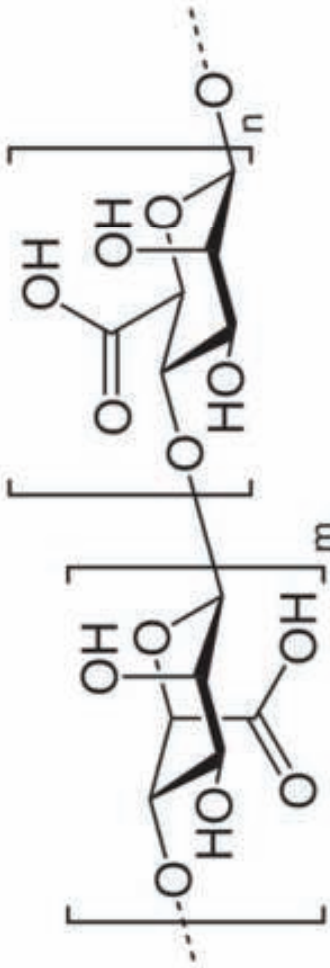
Moritz MSM, 2015. *Jof Integr Agric*
Verbruggen S, 2017. *Cytotechnology*

.....stretching too!



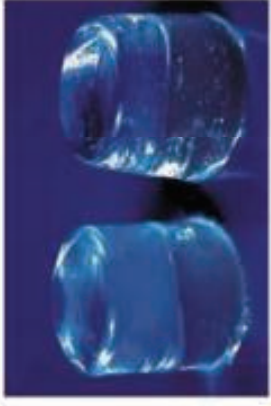
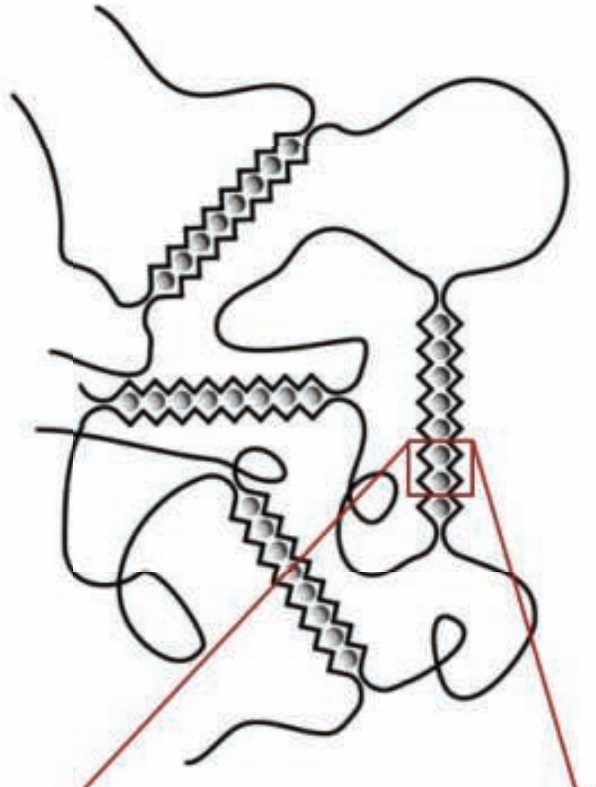
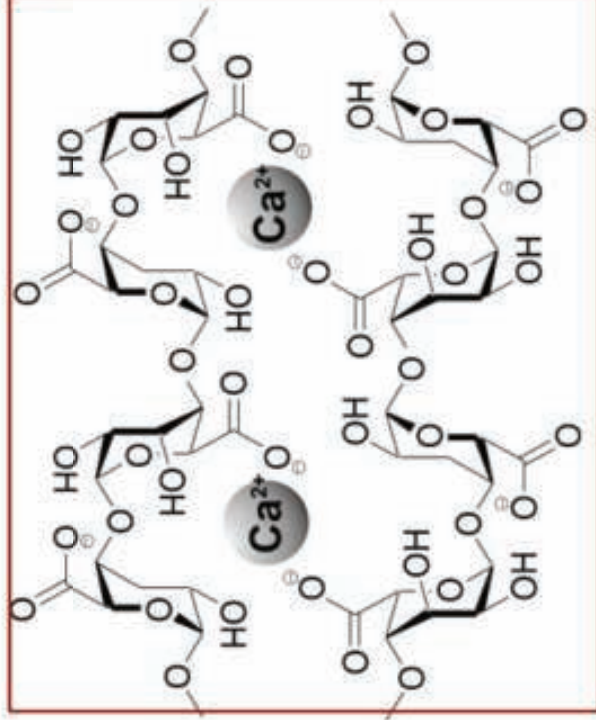
B



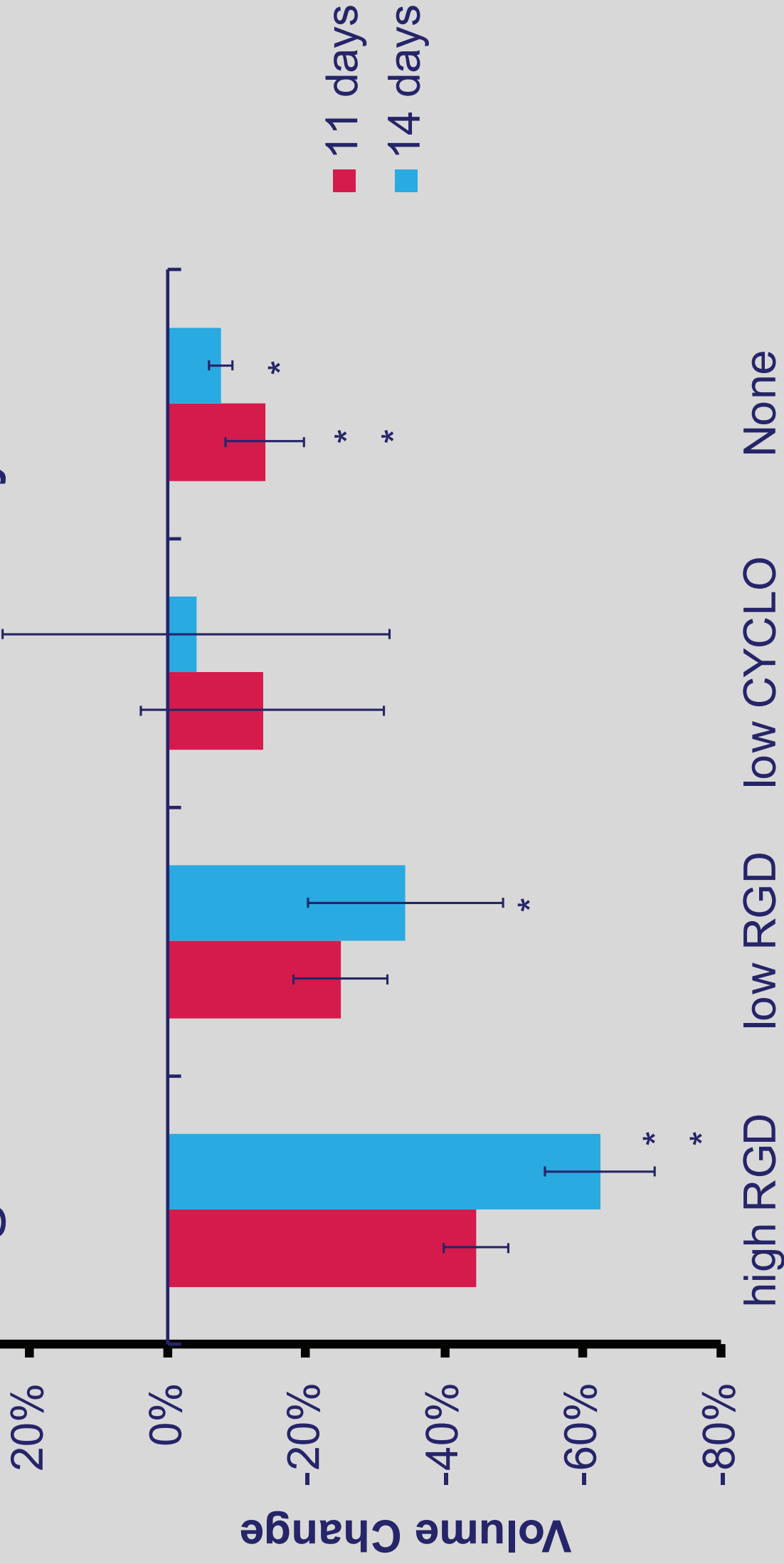


(G) guluronic **(M) mannuronic**

↓ **Ca²⁺**



Alginate Contraction with myoblasts



Alternative polymers

- cellulose
- silk
- chitin
- carrageenan
- functionalization



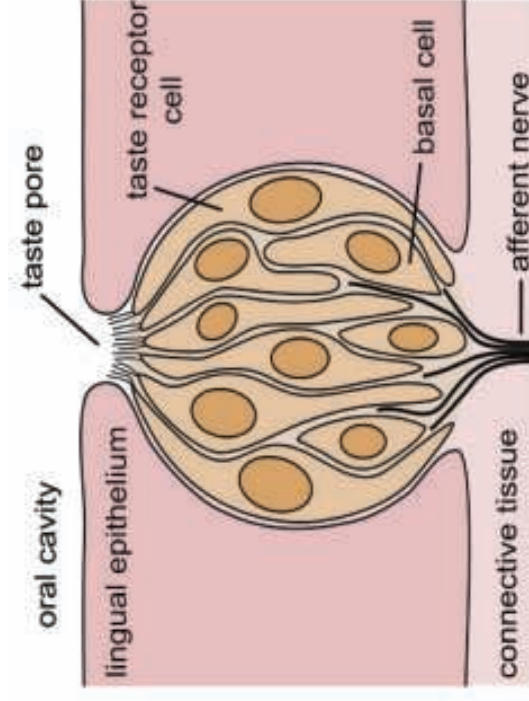
MIMICRY



color



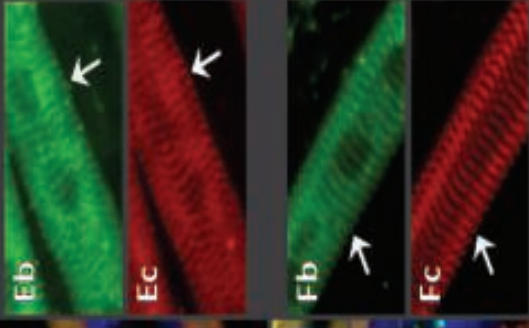
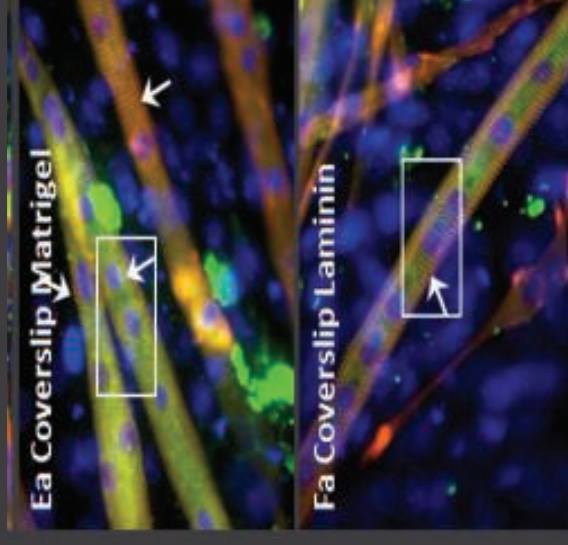
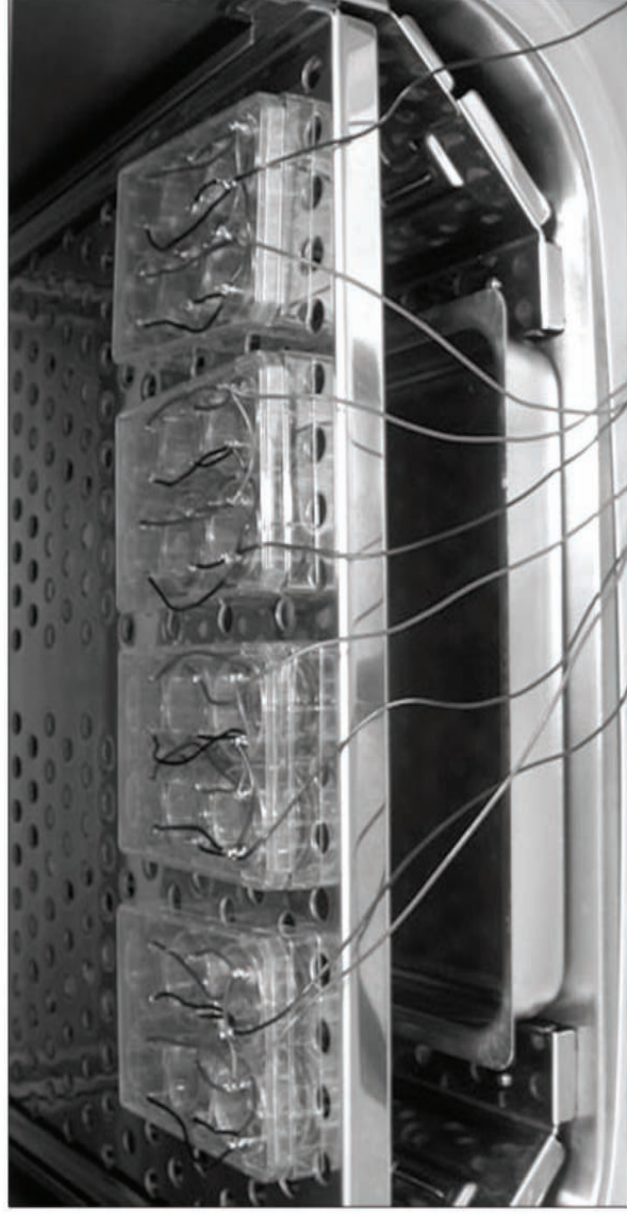
texture



taste

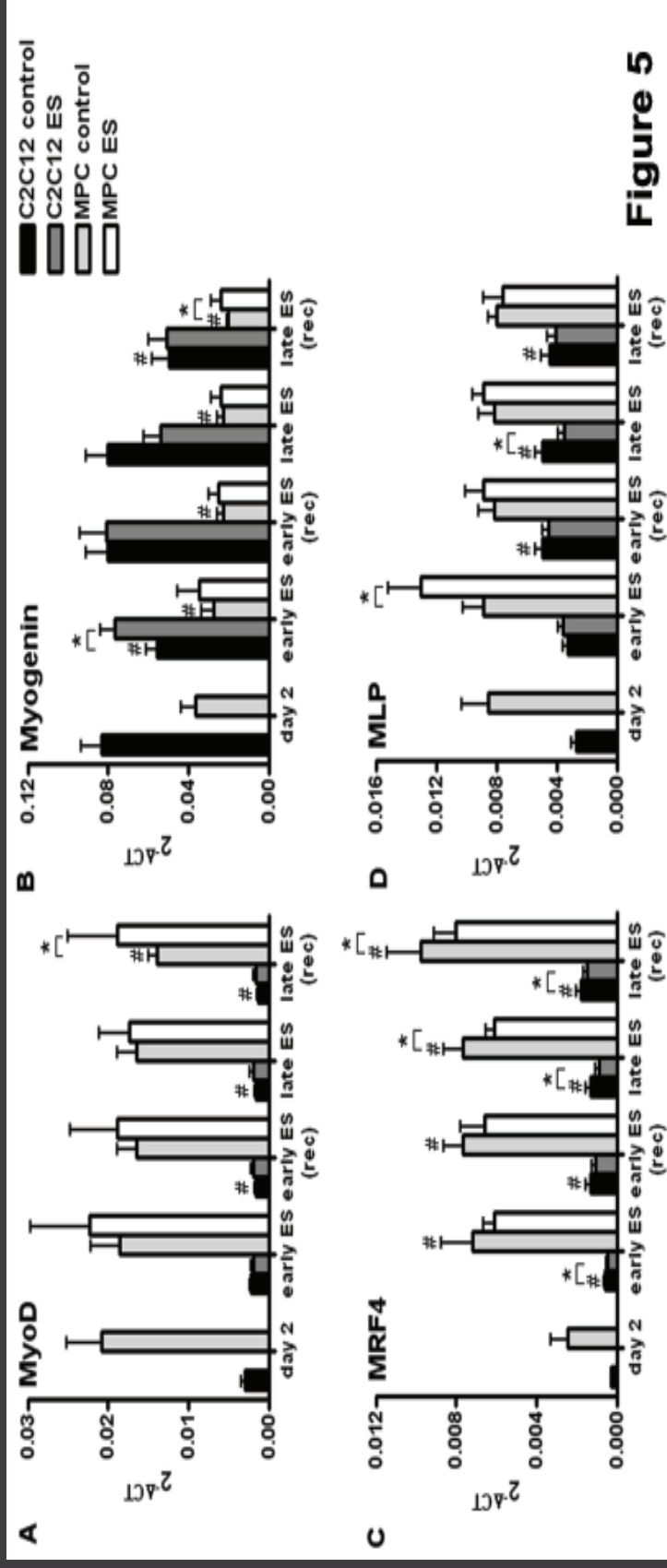
The laboratory “gym”

A.



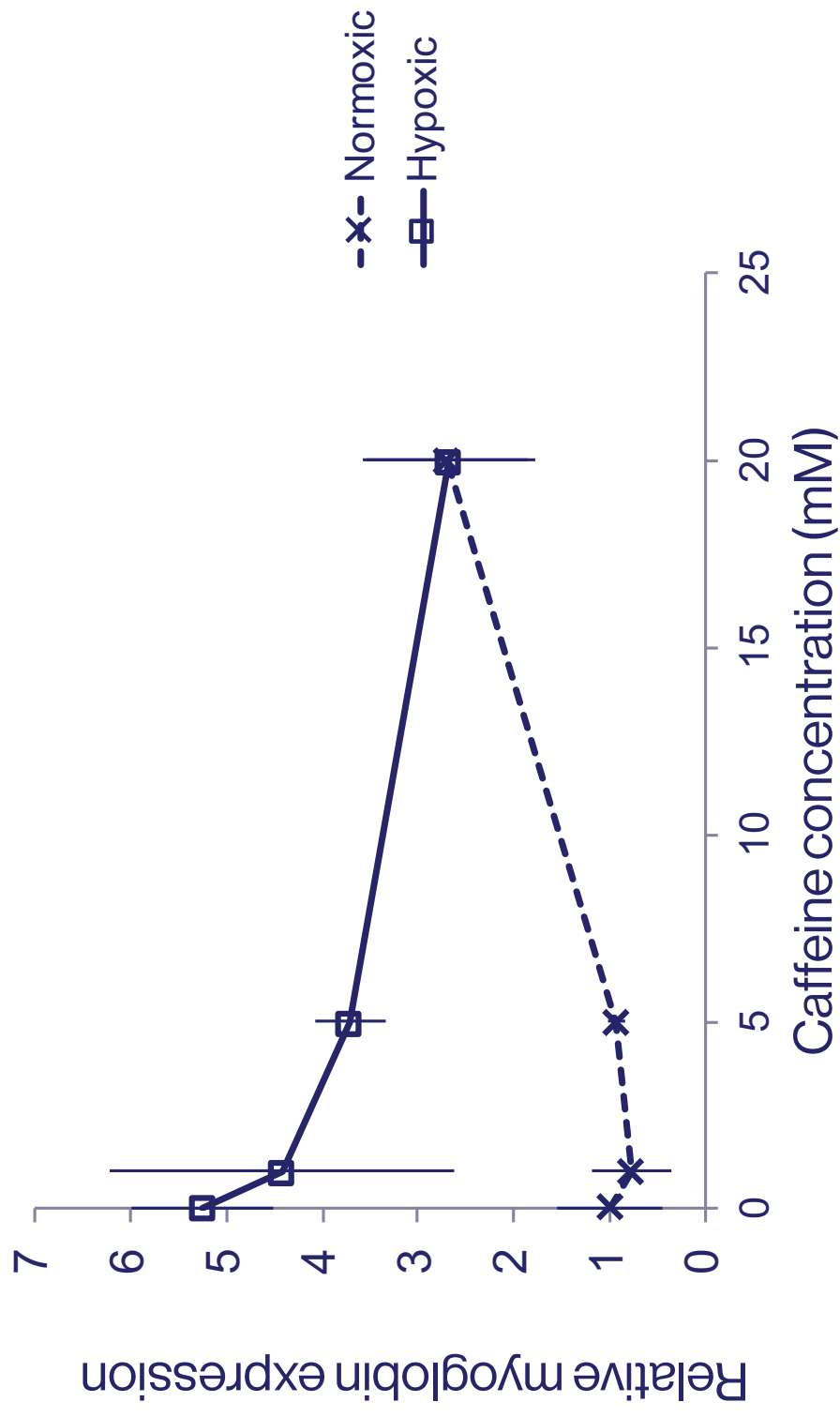
Langelaan ML, et al: *TERM*, 5(7), 529-539 (2011).
Boonen KJ, et al.: *TERM* 5(1), 60-68 (2011).
Langelaan ML et al: *Trends Food Sci Technol* 21(2), 7 (2010).

Electrical Stimulation improves differentiation



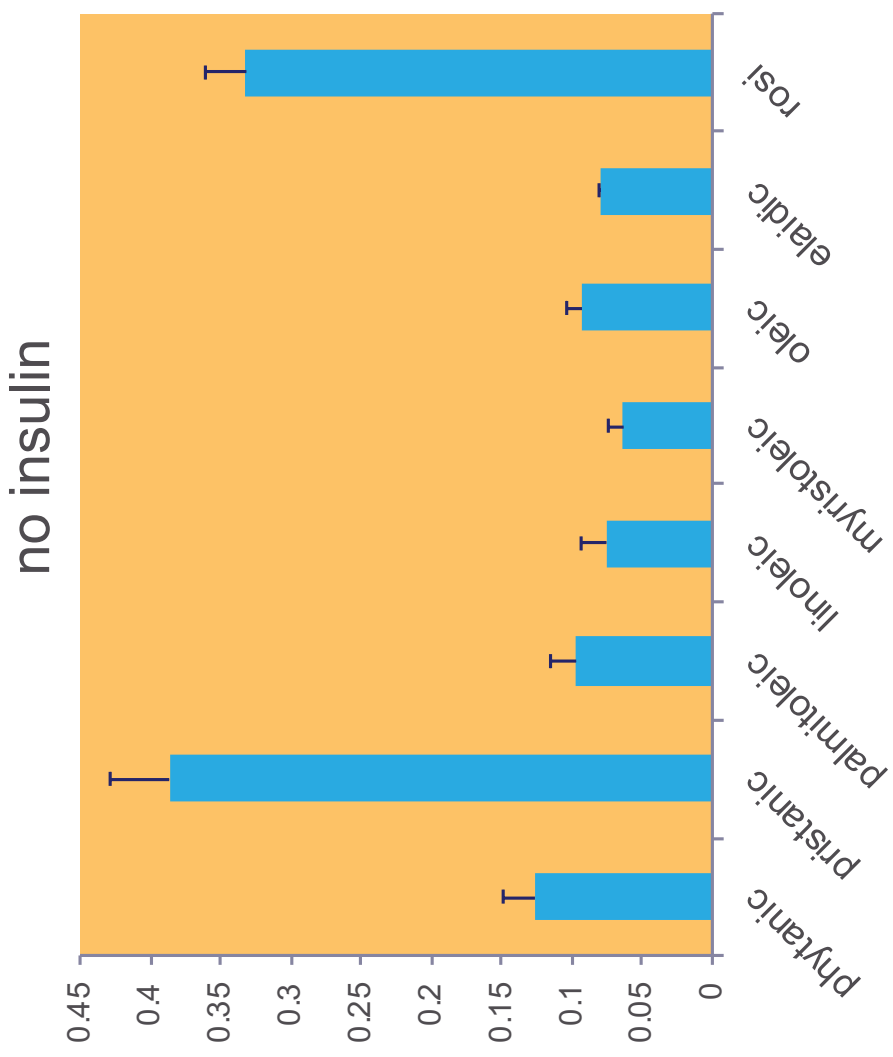
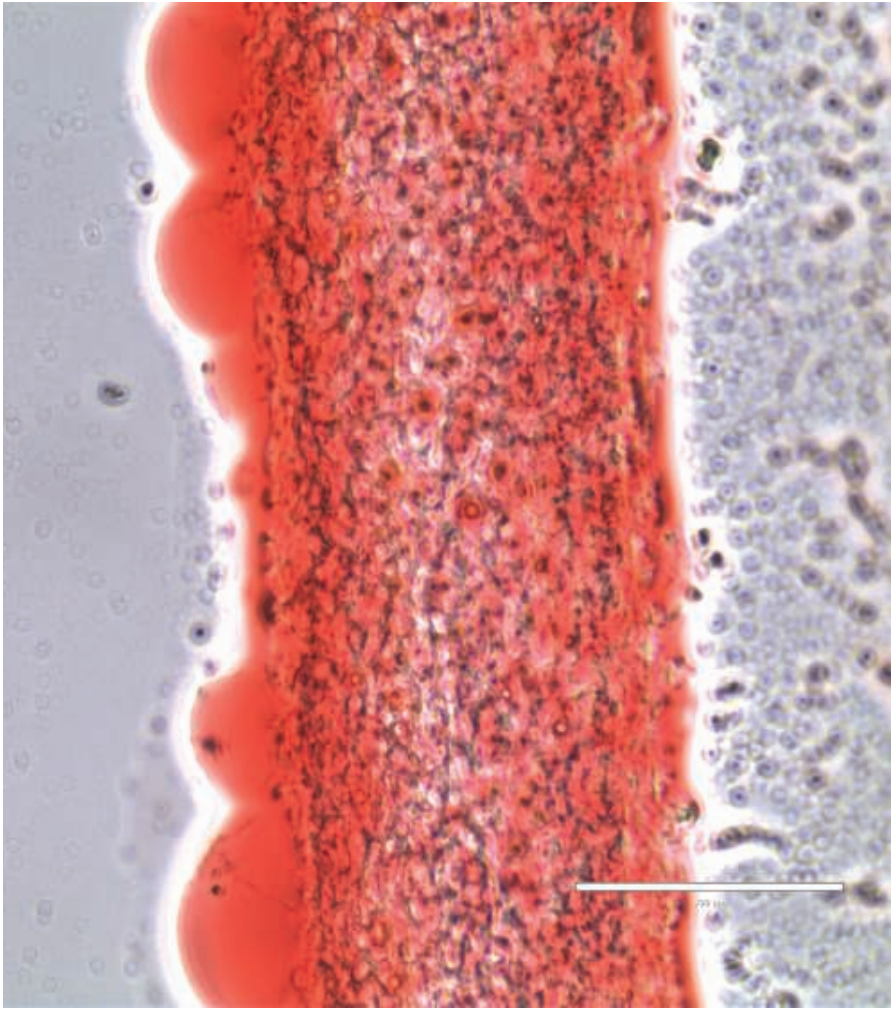
M.Langelaan, J Tissue Eng Regen Med, 2011

Color, Fe^{2+} ?



creating fat tissue

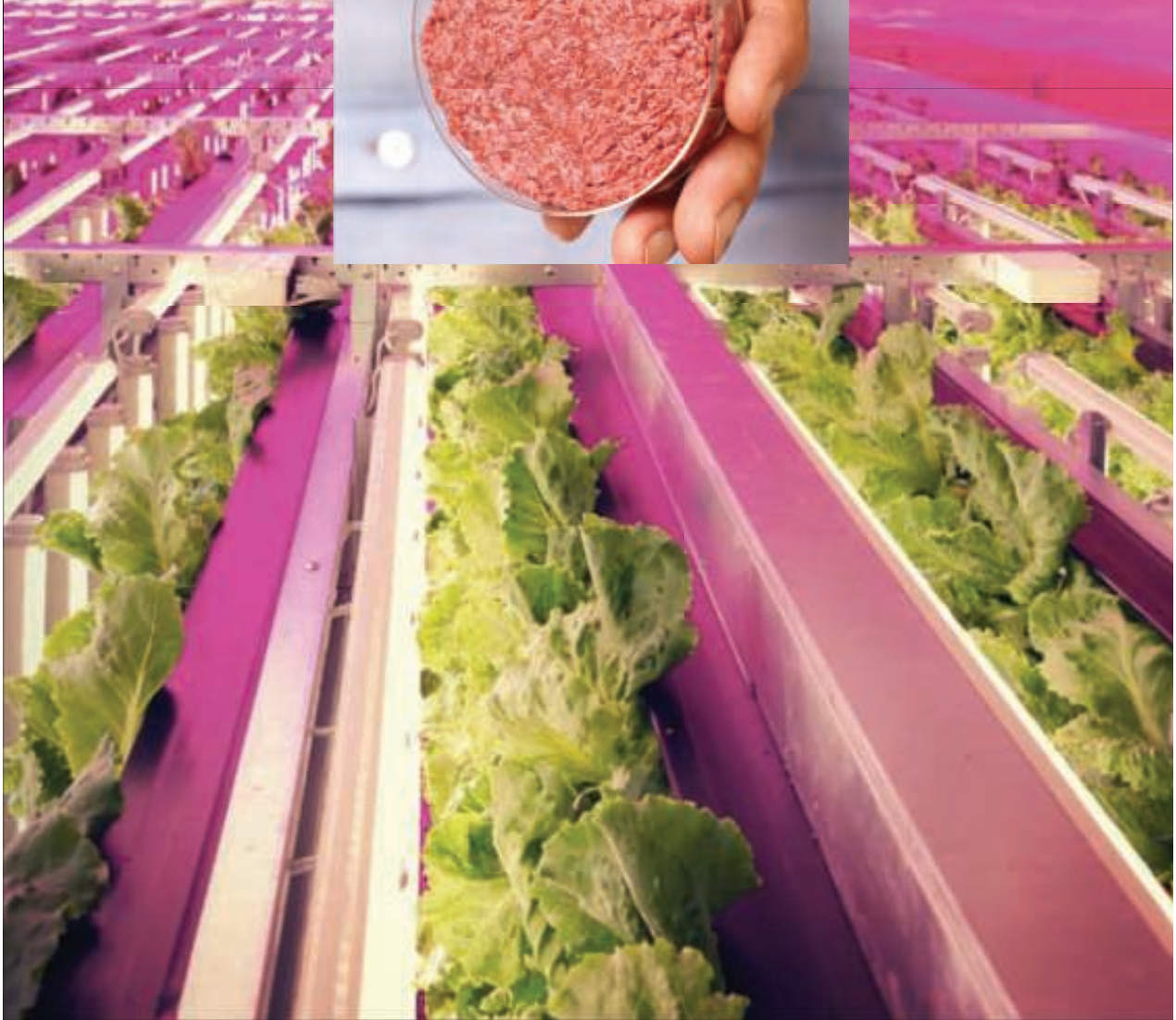
Bovine ADSC in alginate





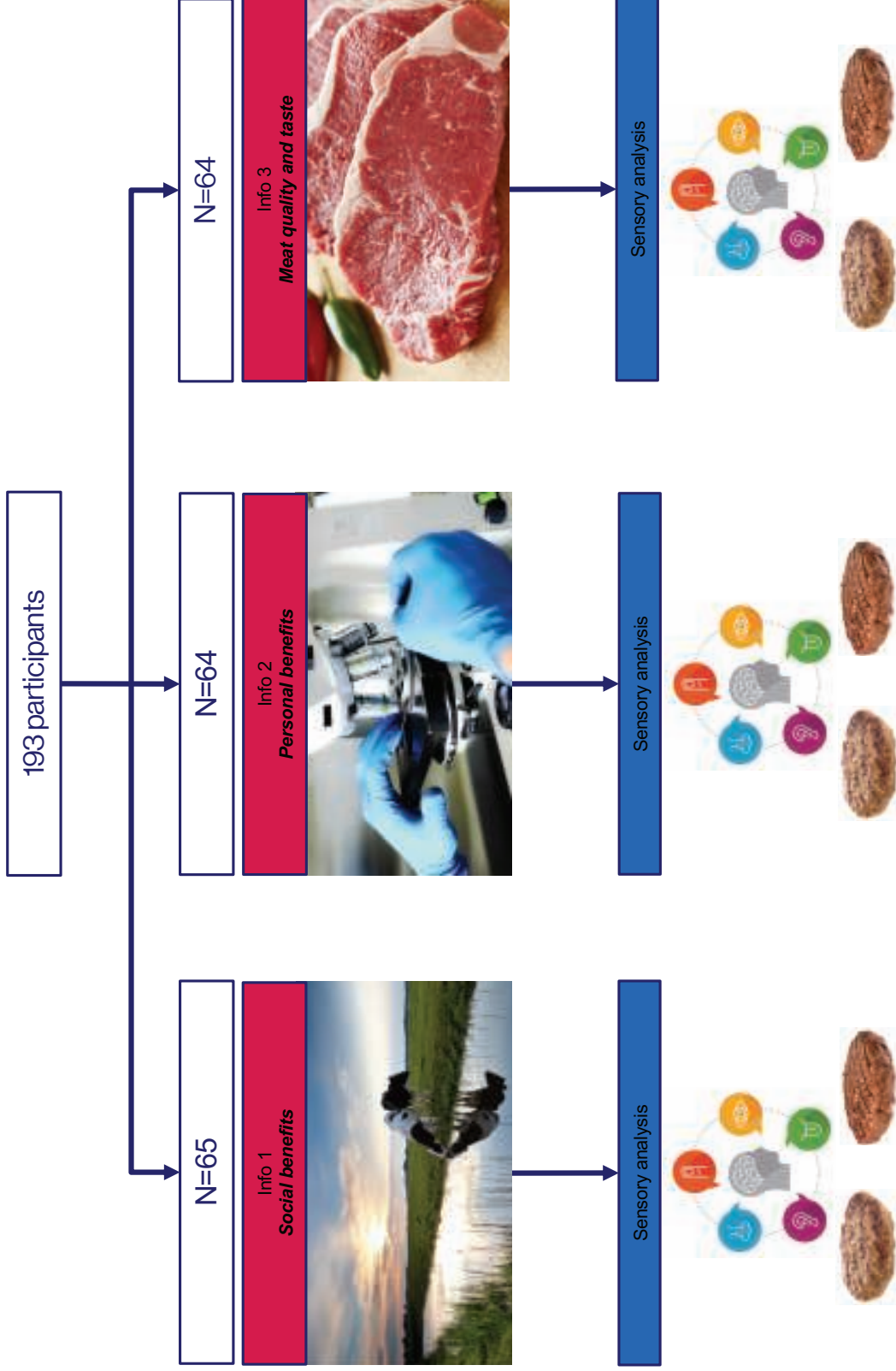




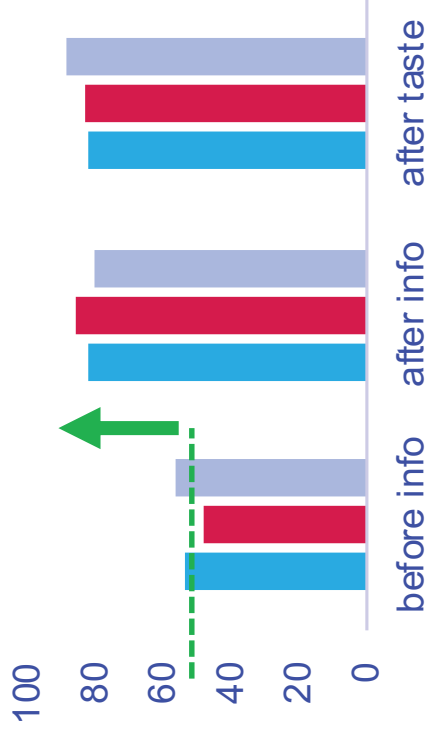




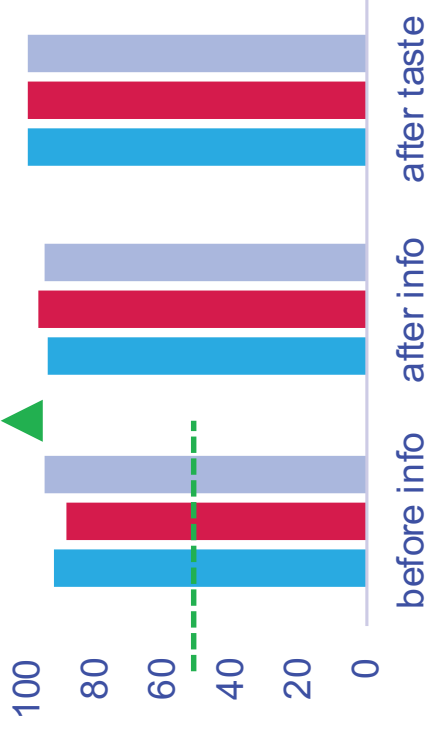
Are acceptance and taste dependent on type of info?



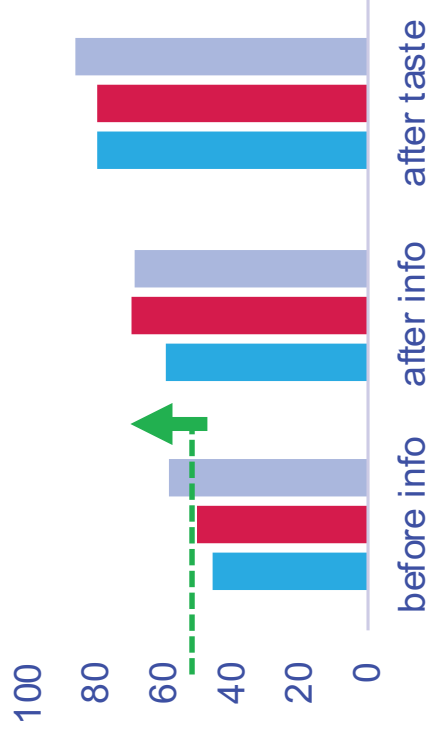
Favour?



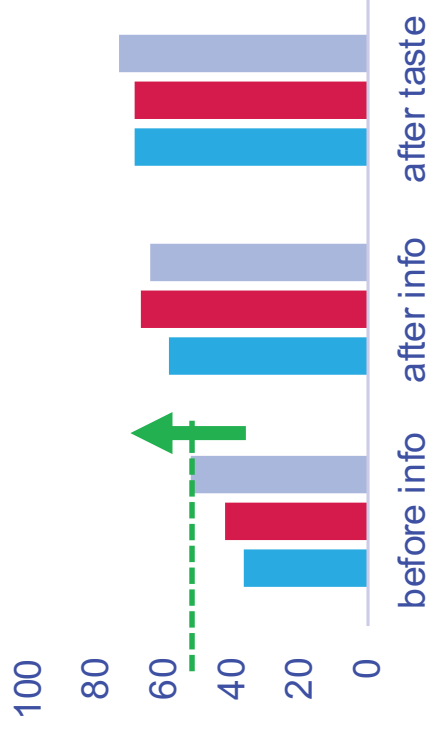
Taste?

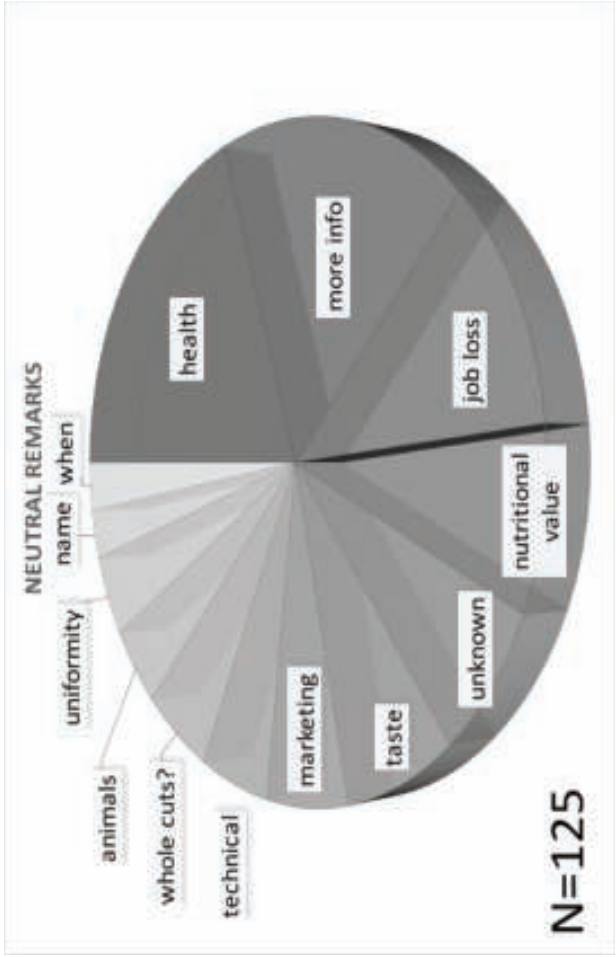
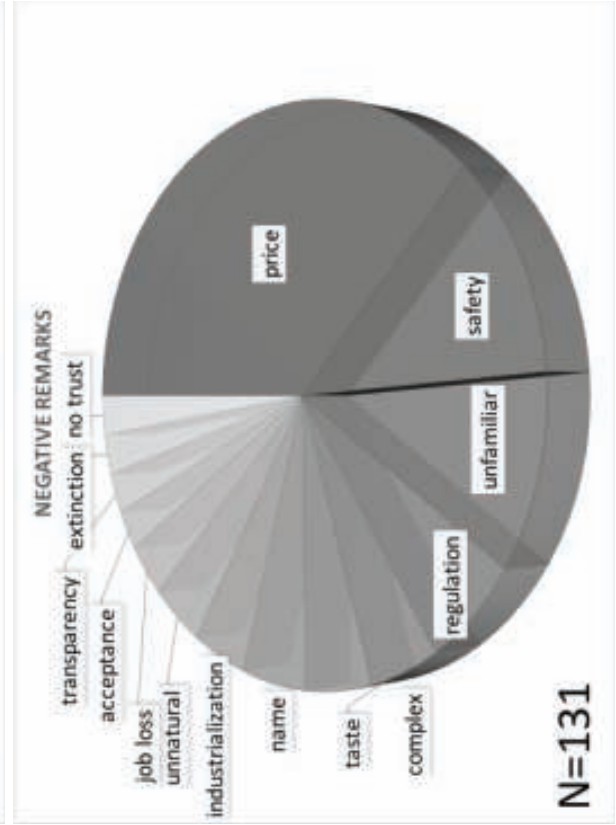
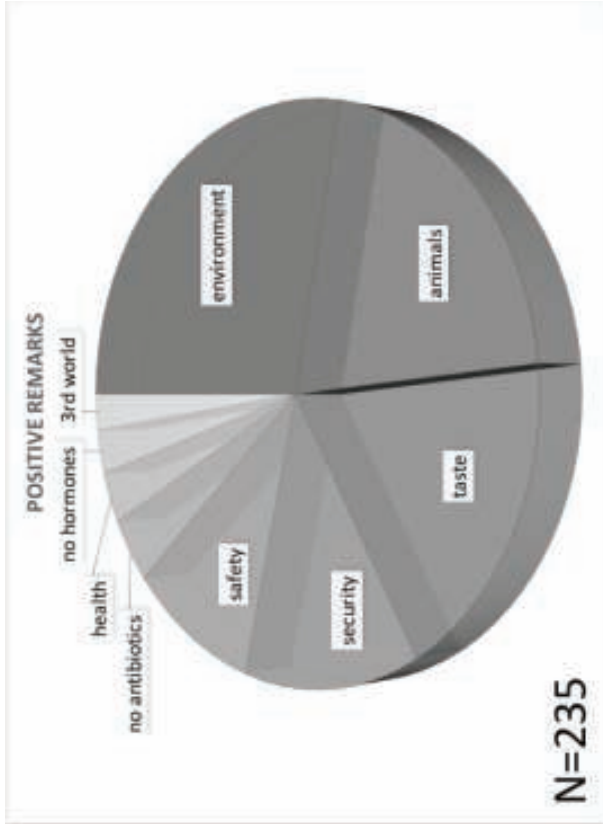


Buy?



Replace?



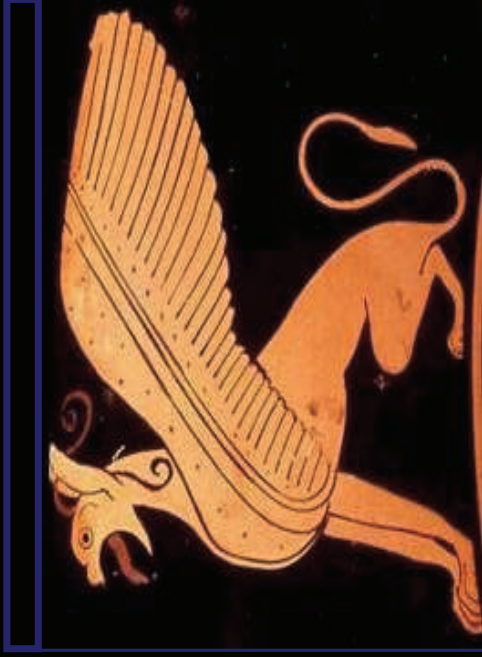


PRESCRIPTION OF THE FUTURE





MENU OF THE FUTURE



TEB Master Cell Bank Production

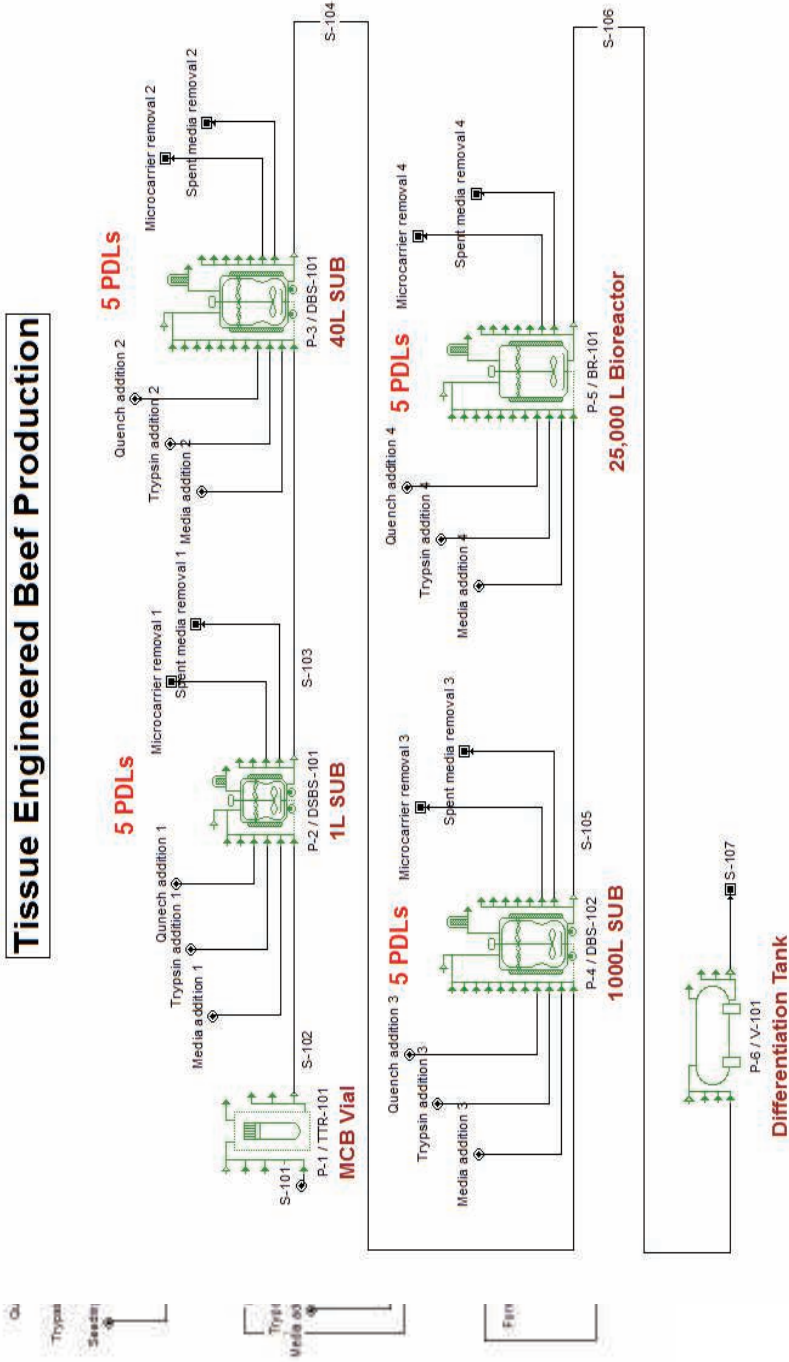
Master Cell Bank Production

Total: 32 PDLs
96 cells → 3072 Vials
Cost per MCB vial: \$330

Process address 3:

Process address 5:

Tissue Engineered Beef Production



Outcomes of the modeling

Cells produced per single batch	1.75E+14
Cells per gram of muscle tissue	5.00E+06
Mass of beef produced in kgs	3.50E+04
Cost per kg of beef production	\$ 65.57
Population fed by single batch	815
Cost per single human being fed	\$ 2,815.87
Population fed by single bioreactor (13 cycles per yr)	10595

data: J. Rowley

THE NEW PROTEIN LANDSCAPE V.1.9

CREATING NEW PROTEIN: CONSUMER GOODS

CLEAN ANIMAL PROTEIN (GROWN FROM CELLULAR AGRICULTURE)



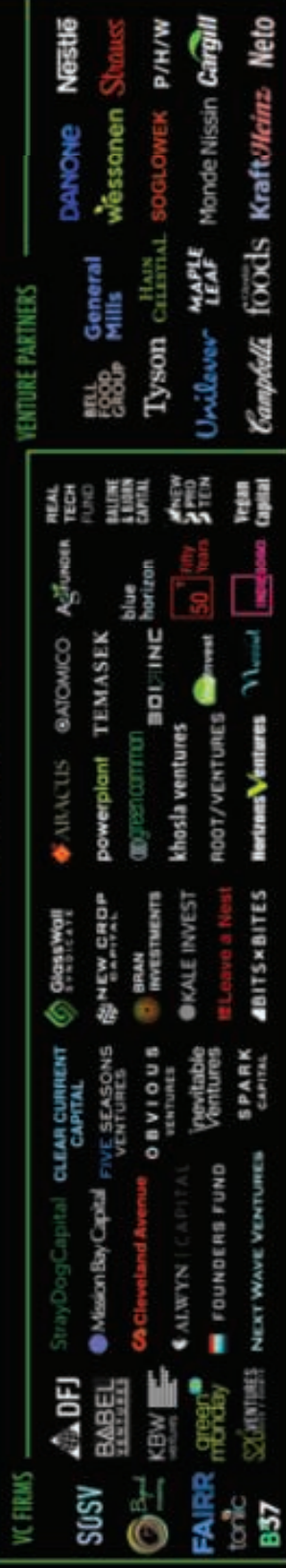
NON-ANIMAL PROTEIN



SUPPORTING NEW PROTEIN



FUNDING NEW PROTEIN



CREATING NEW PROTEIN: INGREDIENTS

