



# Emerging Technologies Shaping the Future of Foods

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W2O Food Innovation

# Emerging Technologies Shaping the Future of Foods



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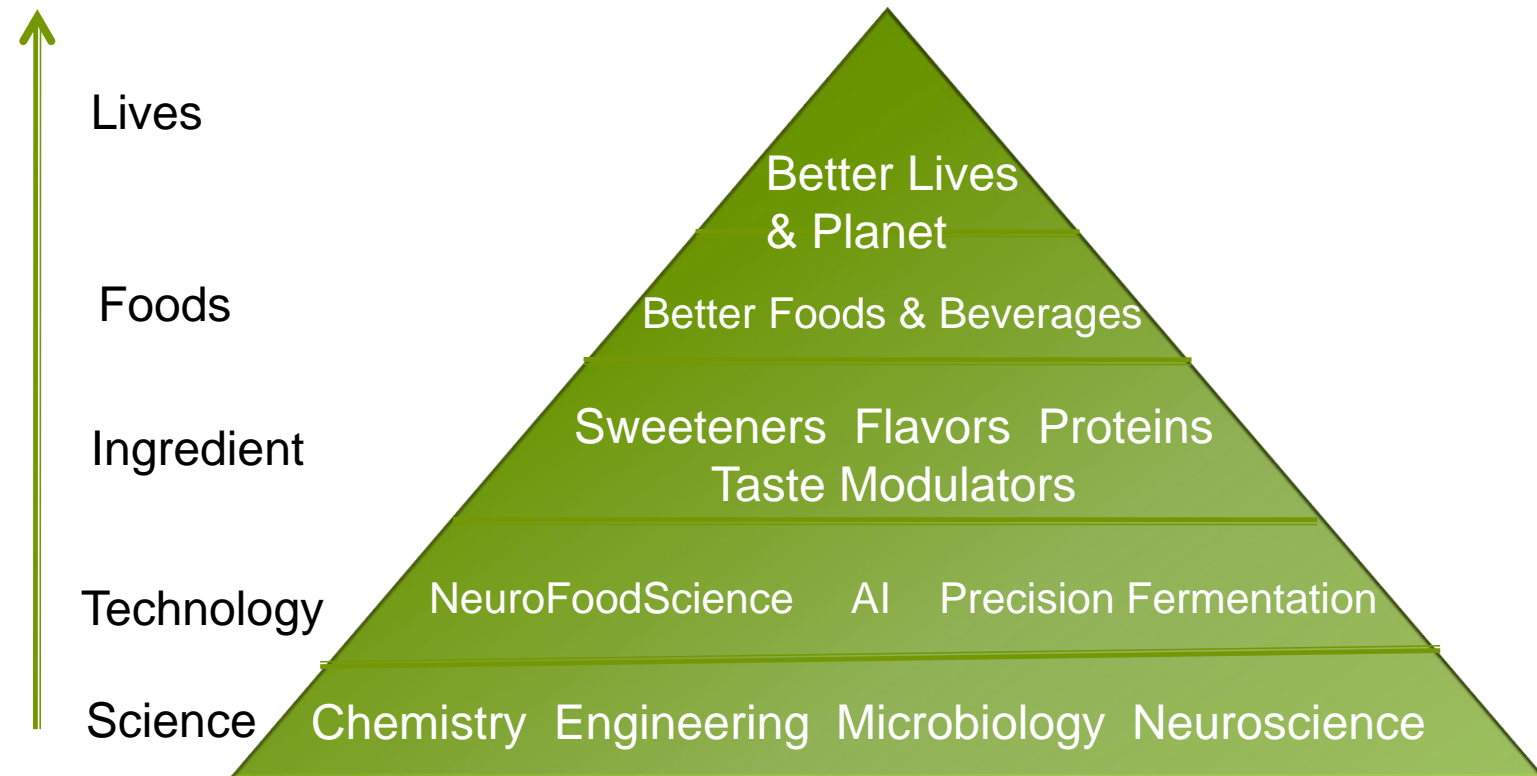
- We should strive to make better foods that are better for human lives and better for our planet
- Science and technologies from neighboring industries could change how we food scientists discover and invent
- Emerging technologies include NeuroFoodScience, Precision Fermentation, and most recently AI. Each technology and its current leader will be critically reviewed.
- So What = What are the technologies + what do they mean to you + what can you do about them?

# Outline

- Module 1: Basic Concepts
- Module 2: Three Technologies
- Module 3: So What?



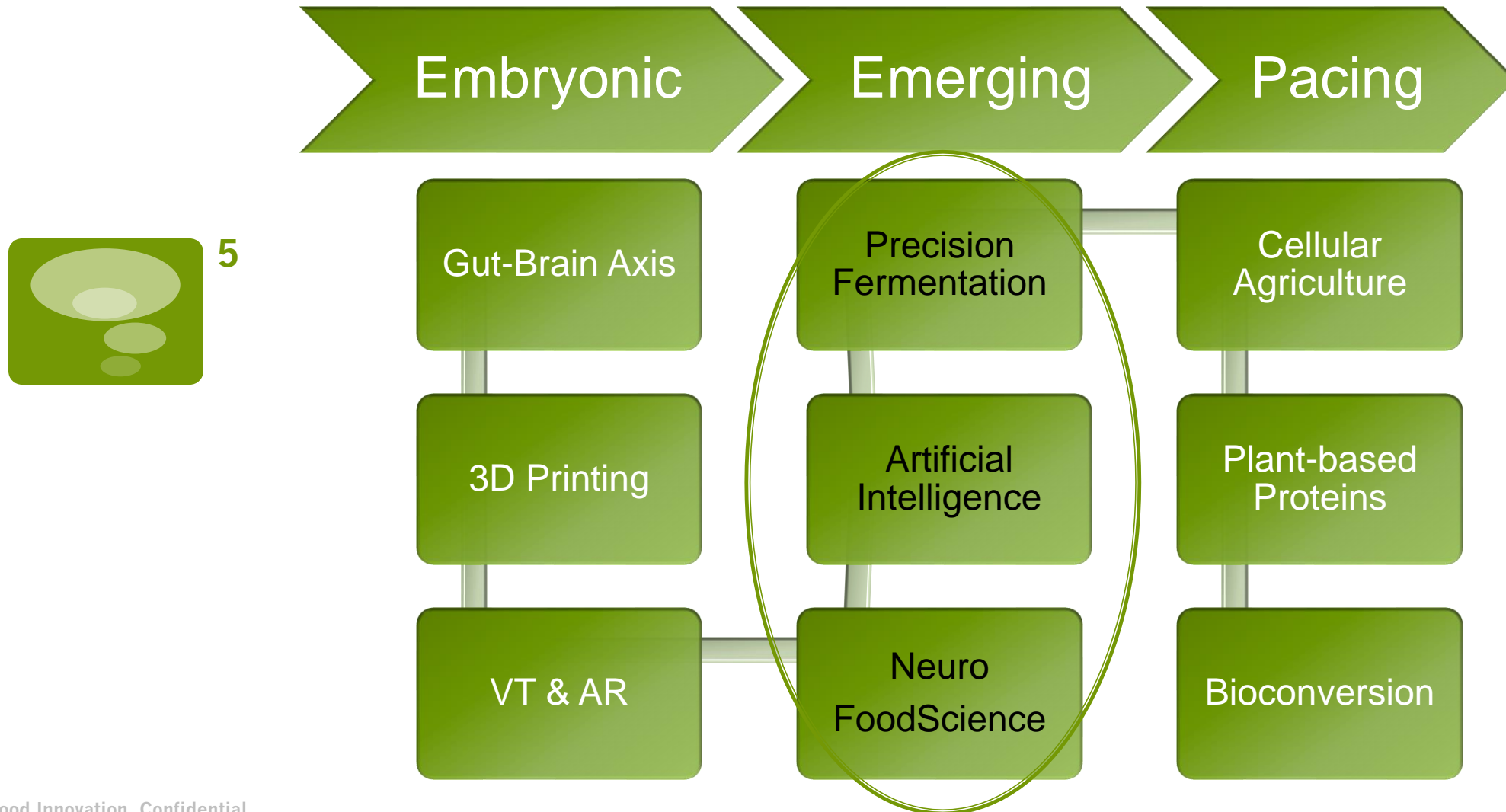
# Science Leads to Technology, Which Leads to Better Foods for Better Lives and Better Planet. (W2O, 2023)



# Food Technology Map:

All technologies go from Embryonic, to Emerging, to Pacing, to Mature.

(McKinsey 1990's, W2O, 2023)



# Outline



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# NeuroFoodScience (W2O, 2023)



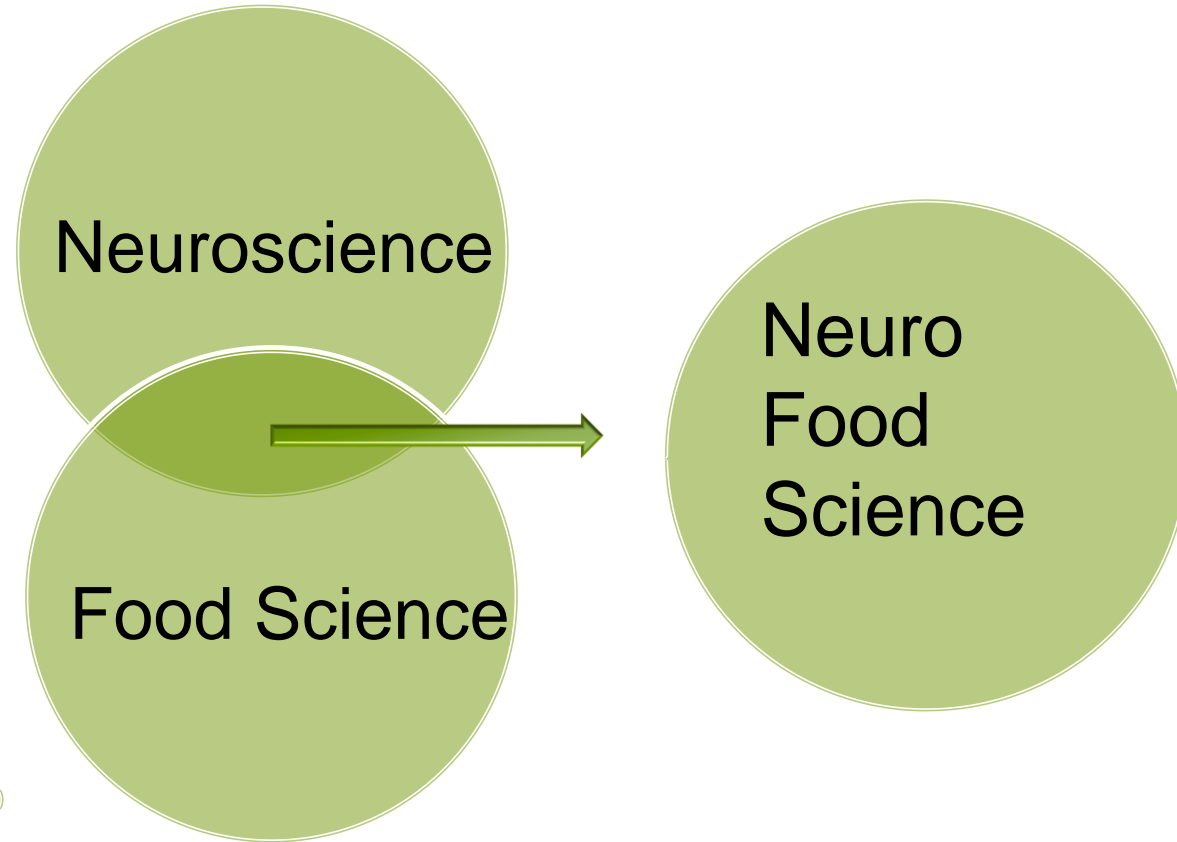
**What is it?  
What does it do?  
How ?**

- Focus: Flavor detection and perception
- Flavor= all 5 senses. Taste +Smell +Sight +Sound +Touch
- All plant-based ingredients

**What are the Features & Benefits?**

- Features:
  - Sugar reduction
  - Salt reduction
  - Multisensory experience
- Benefits:
  - Better foods
  - Better human lives
  - Better planet

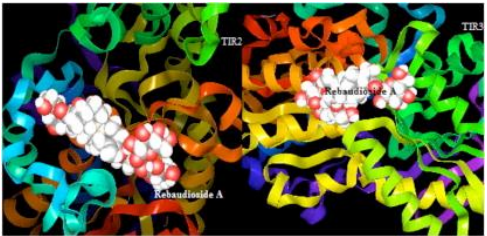
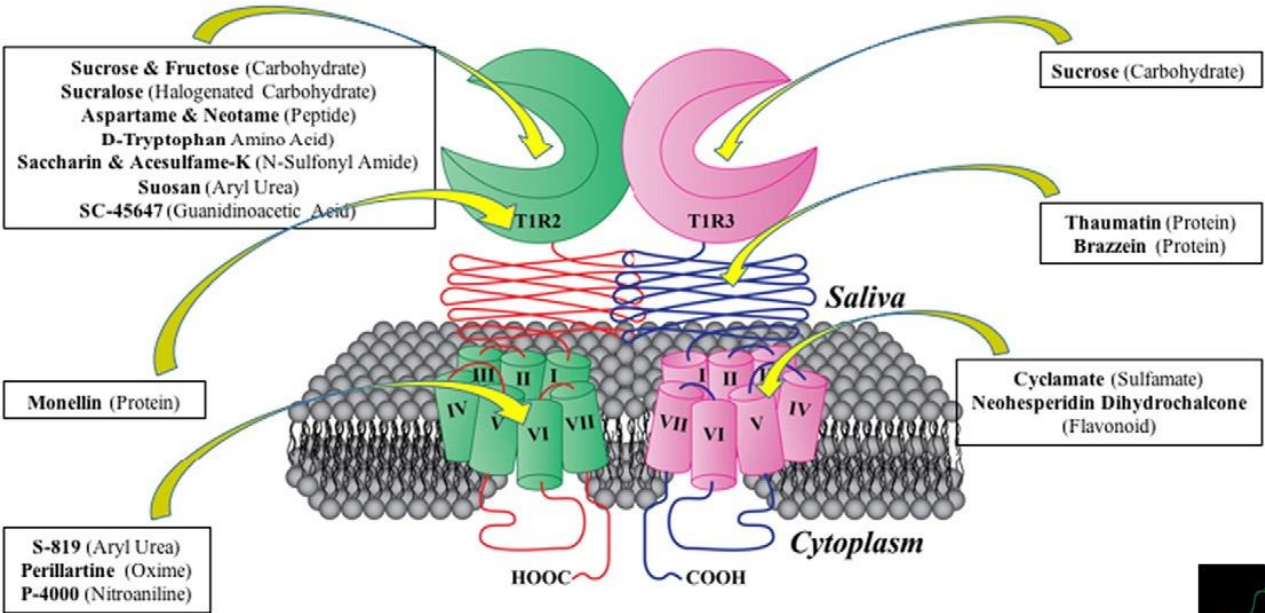
# NeuroFoodScience: Apply contemporary taste and smell neuroscience to create better foods (W2O, 2023)





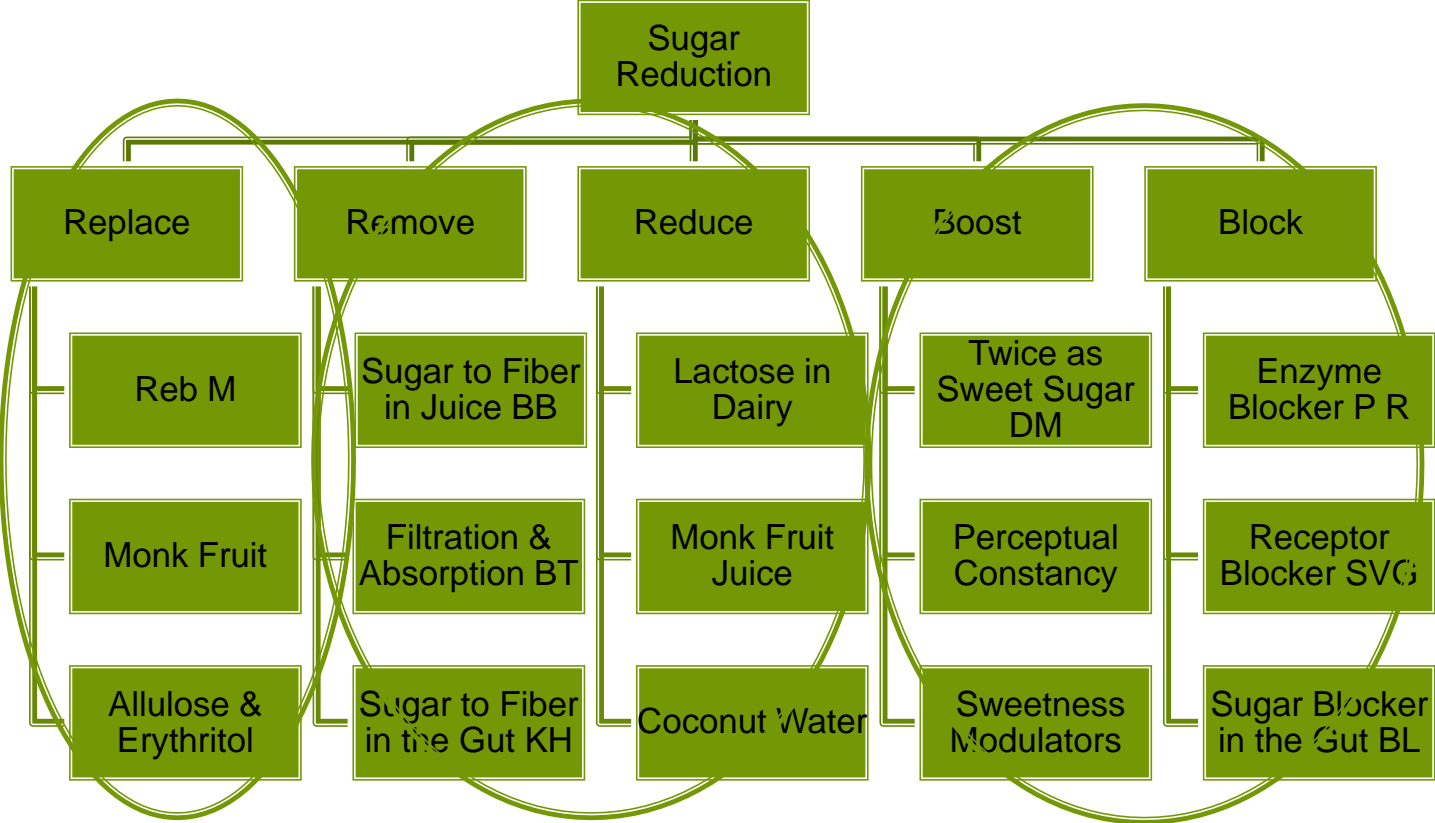
# Sweetness Receptor Works Like This.....

Sweeteners bind to different locations in the taste receptor: Venus Flytrap Domain, Cysteine-Rich Domain, and 7 Trans Membrane Domain (DuBois, 2016, Masuda, 2012. Lefkowitz and Kobilka, 2012). Binding led to receptor protein conformational change (Deriu et al, 2020). Reb A activated T1R2 VFT (Arodola et al, 2020). Sweet receptor cells instructed sweet neurons via SEMA 7A signaling protein (Zucker et al, 2017). (Figure from DuBois, 2016)

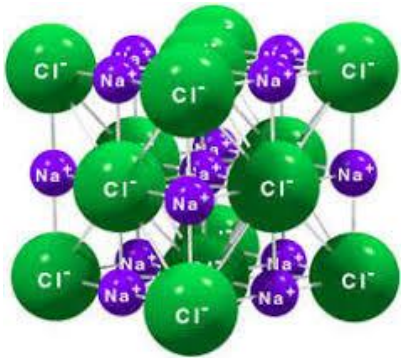
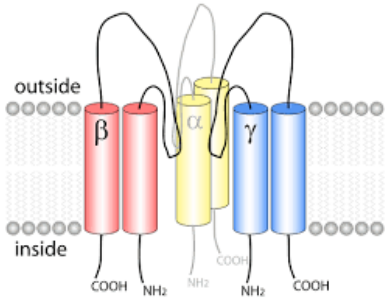


# Sugar Reduction:

There are 5 strategies, 3R2B. (W2O, 2023)



# Saltiness: Detection and Perception



- **Detection:**

- **ENaC:** (Nomura et al, 2020)

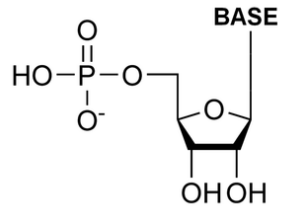
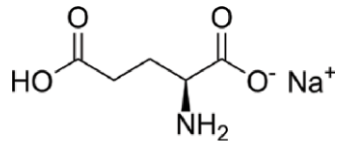
- These ion channels have transmembrane domains joined by a large extracellular loop, are selective for Na over other cations.
- ENaC is likely a trimer and composed of 3 subunits

- **Secondary pathway:** Non-selective to Na thus responds to both high level NaCl and any level KCl. (Chemosensory Transduction, Zufall and Munger, 2016. Chap. 16) (Monell, 2016, 2015)

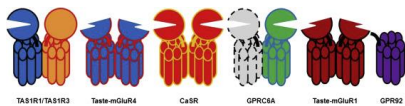
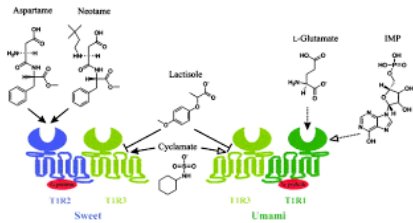
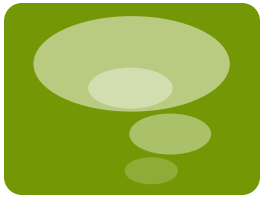
- **Perception:**

- **Low level= salty and appetitive**, high level (>150mM)= bitter and aversive
- A little bit of **salt (0.2%) made vegetables less bitter** (Bakke et al, 2018)
- **Overweight/obese individuals were prone to consume more salt**, had reduced salt sensitivity, and higher preference for salty foods (Li et al, 2017).

# Umami Taste: Detection and Perception

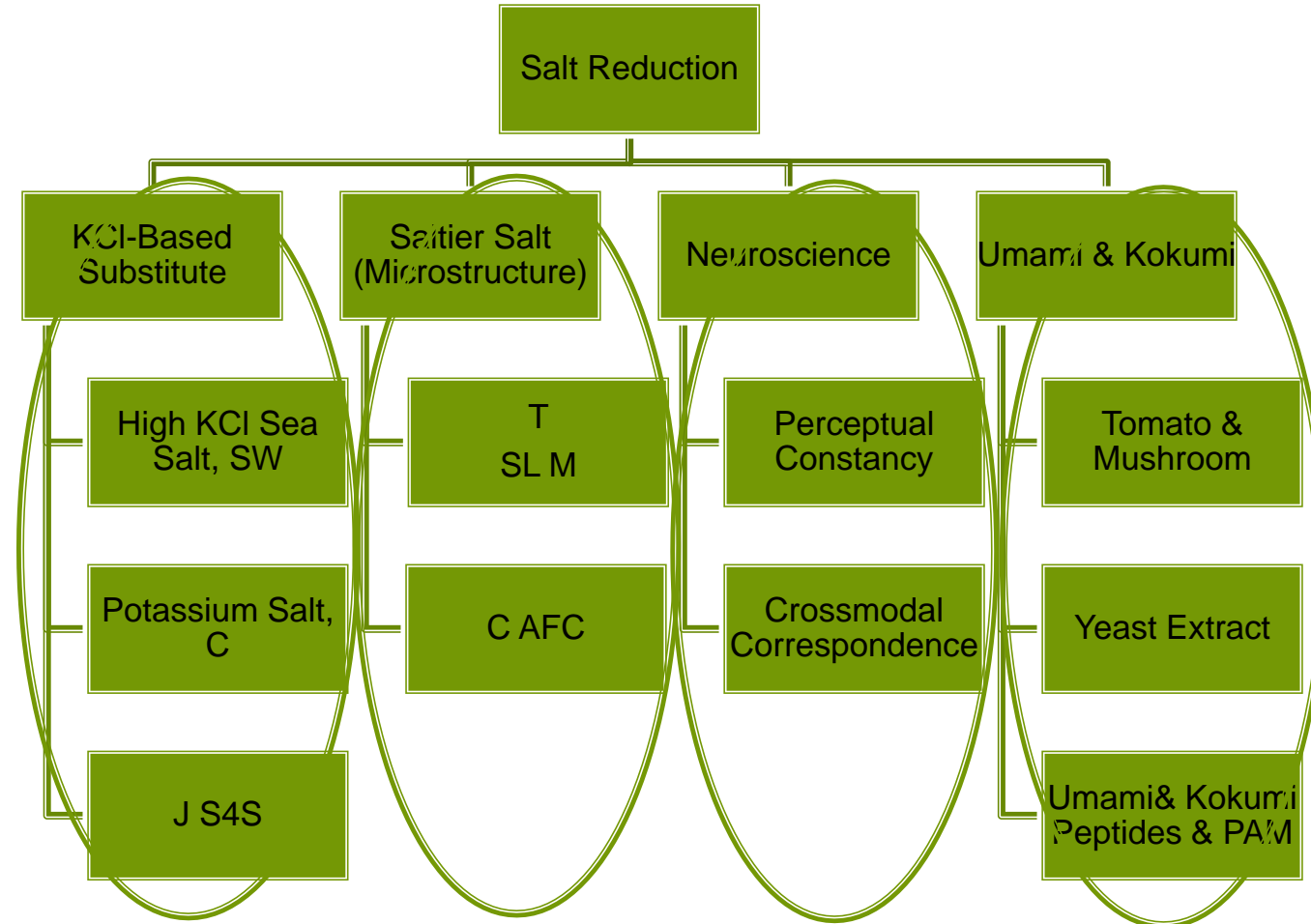


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- Detection:
  - Receptors: All GPCRs
    - **Primary: T1R1/T1R3**, MSG binds at VFT in T1R1 subunit only (Chemosensory Transduction, Zufall and Munger, 2016.)
    - **5 secondary pathways:** Responding to other amino acids and peptides  
Taste-mGluR4, Taste-mGluR1, CaSR, GCPR6A, GPR93.
- Perception:
  - MSG: **Umami= “Delicious”**
  - More umami at higher temperature (Green et al, 2016)
  - Could be a flavor enhancer, in addition to being a basic taste. (Kerry and Monell, 2019)
- Regulatory:
  - USA: GRAS (MSG) labeled as MSG, Codex: Natural flavour

Salt Reduction: There are 4 strategies which are substitutes, saltier salt, neuroscience and umami. (W2O, 2023)



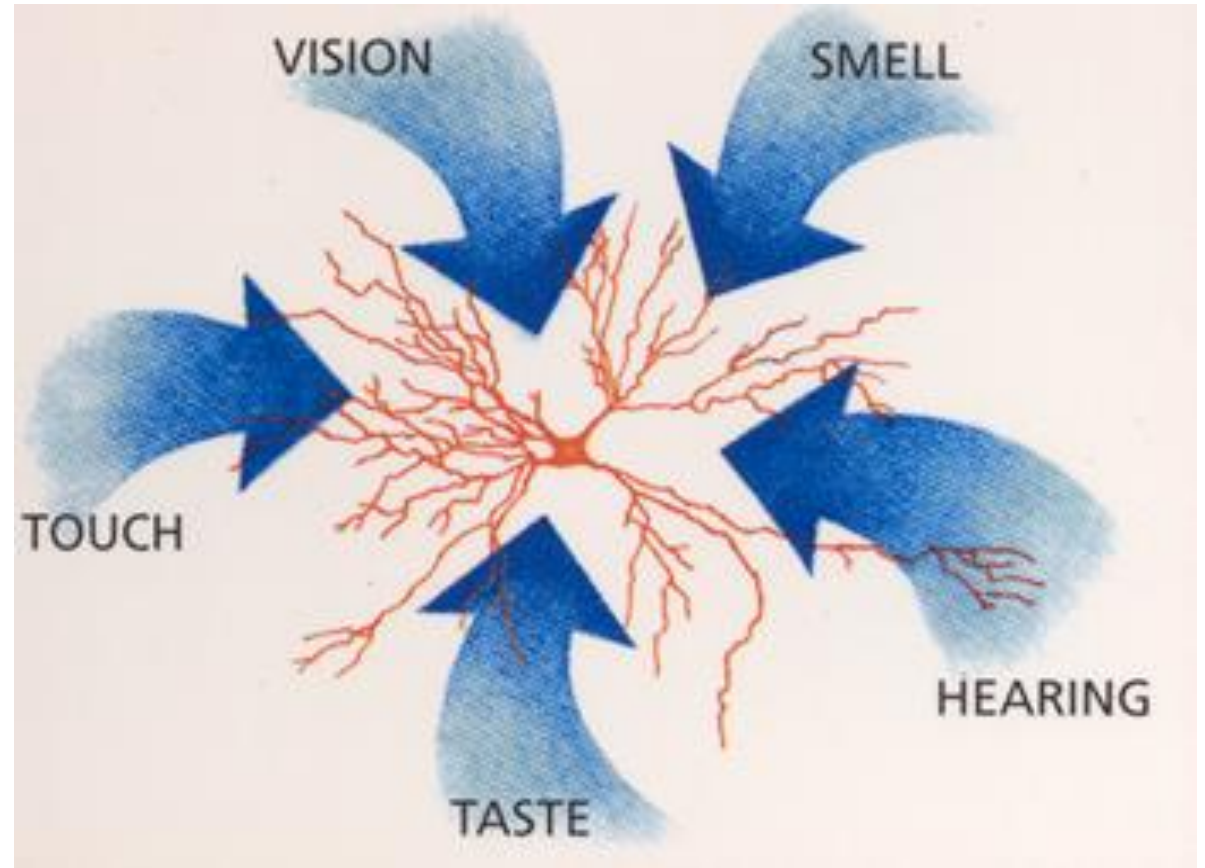
# Crossmodal Correspondence

How brain process information from different senses to form multisensory experiences in our daily lives (Spence, 2023, 2020, 2019, 2013. Velasco et al, 2018) under “unity assumption” (Chen & Spence, 2017)



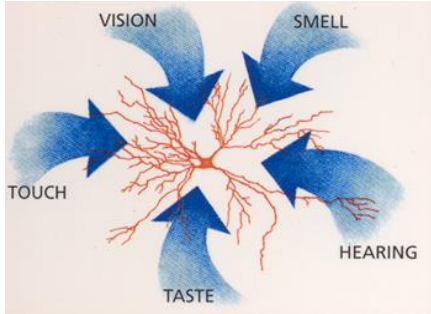
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- Taste
- Smell
- Sight
- Sound
- Touch





# Multisensory Eating & Drinking Experience: What it is and how to create it?



❑ Multisensory eating and drinking experience is based on crossmodal correspondence of all five senses.



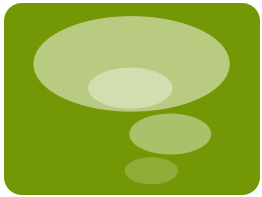
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❑ It is not just food's taste and smell, but the integration with sight, sound and touch delivered by foods, packaging and the immediate environment.

❑ It is also not just to make better foods, but also to make better life for those who lost some of their senses.



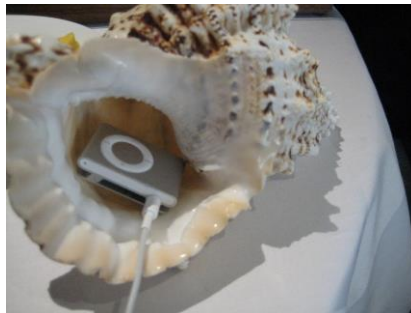
# Best Example of Multisensory Eating & Drinking Experience



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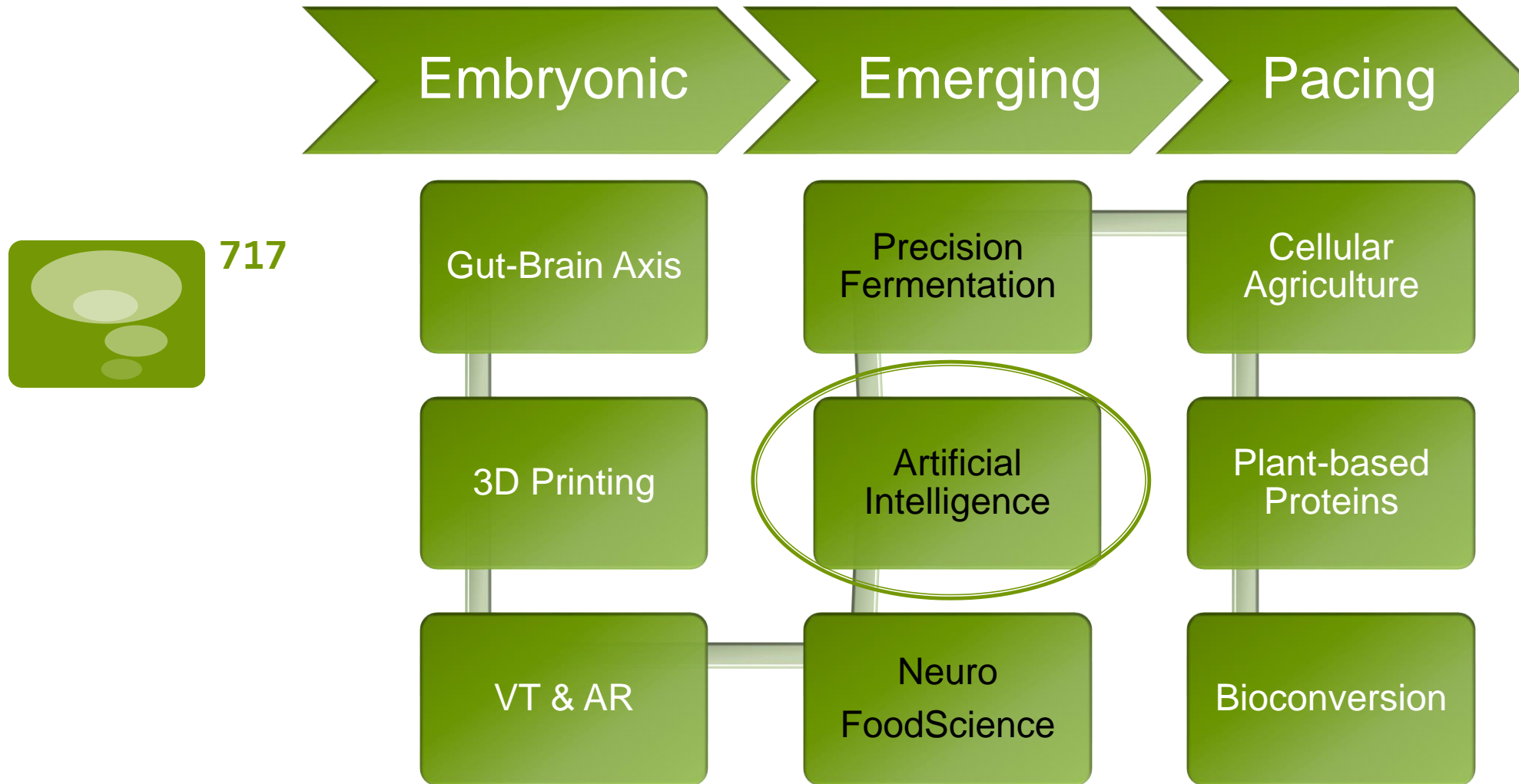
- Fat Duck Restaurant, UK
- Sound of the Sea, a seafood dish with seaside sound (Heston Blumenthal)
- What is it?
  - A signature dish
  - Multisensory: All 5 senses
- What makes it different?
  - “Sonically Seasoned”: Seafood, seaweed, and edible “sand” are “the edge of the seashore”, accompanied by an iPod and earphones for the sounds of the waves lapping up against the shore... (Heston Blumenthal, 2015)
  - The ultimate multisensory dining experience





# Food Technology Map:

All technologies go from Embryonic to Emerging to Pacing to Mature (W2O, 2023)



# Artificial Intelligence

(GlobalData 2023, PeakBridge 2023, New Scientist 2023)



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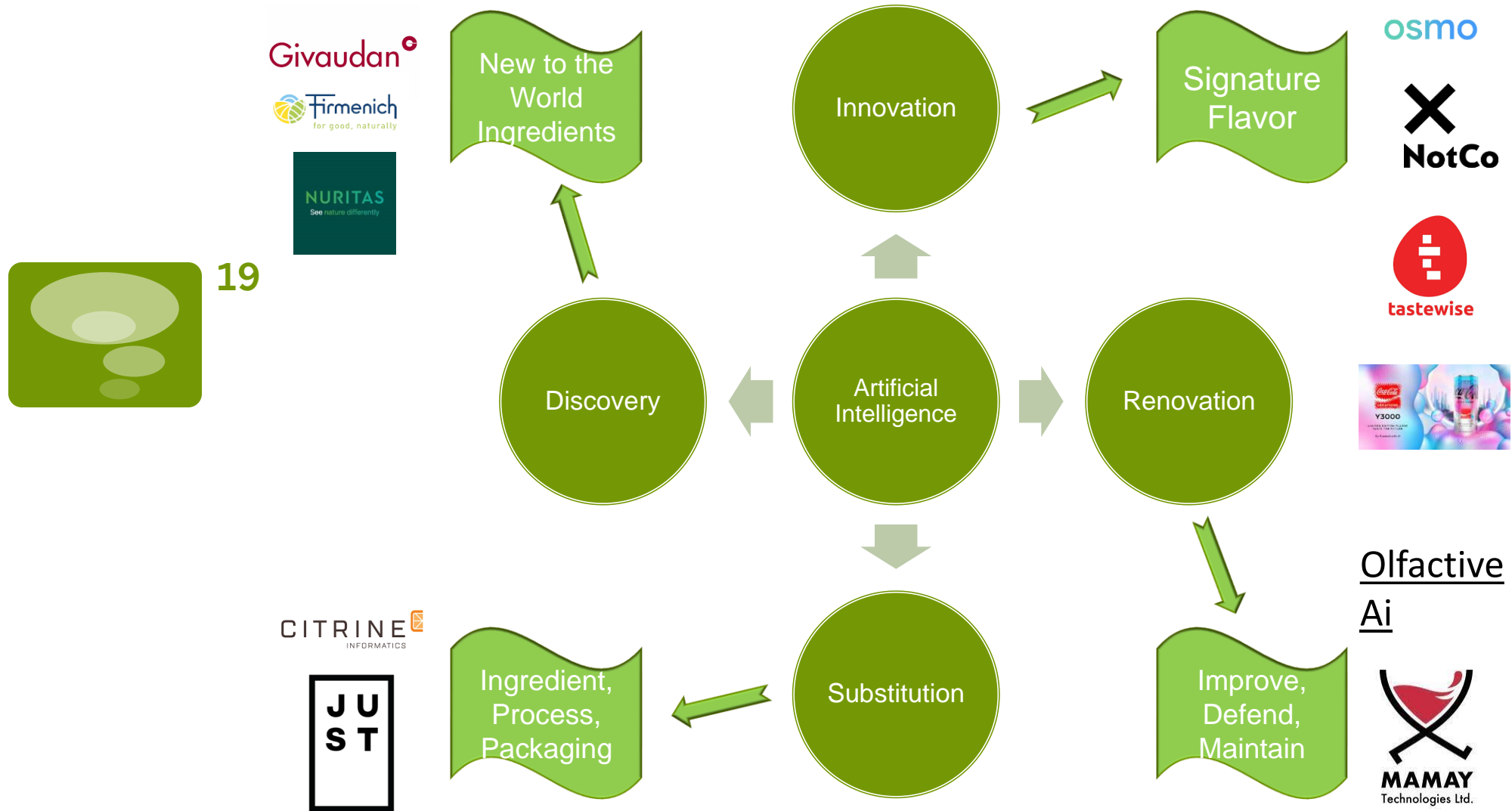
## What is it? What does it do? How ?

- Artificial intelligence (AI) is a set of technologies that enable computers to perform a variety of advanced functions, including the ability to see, understand and translate spoken and written language, analyze data, make recommendations, and more. (Google.com)

## What are the Features & Benefits?

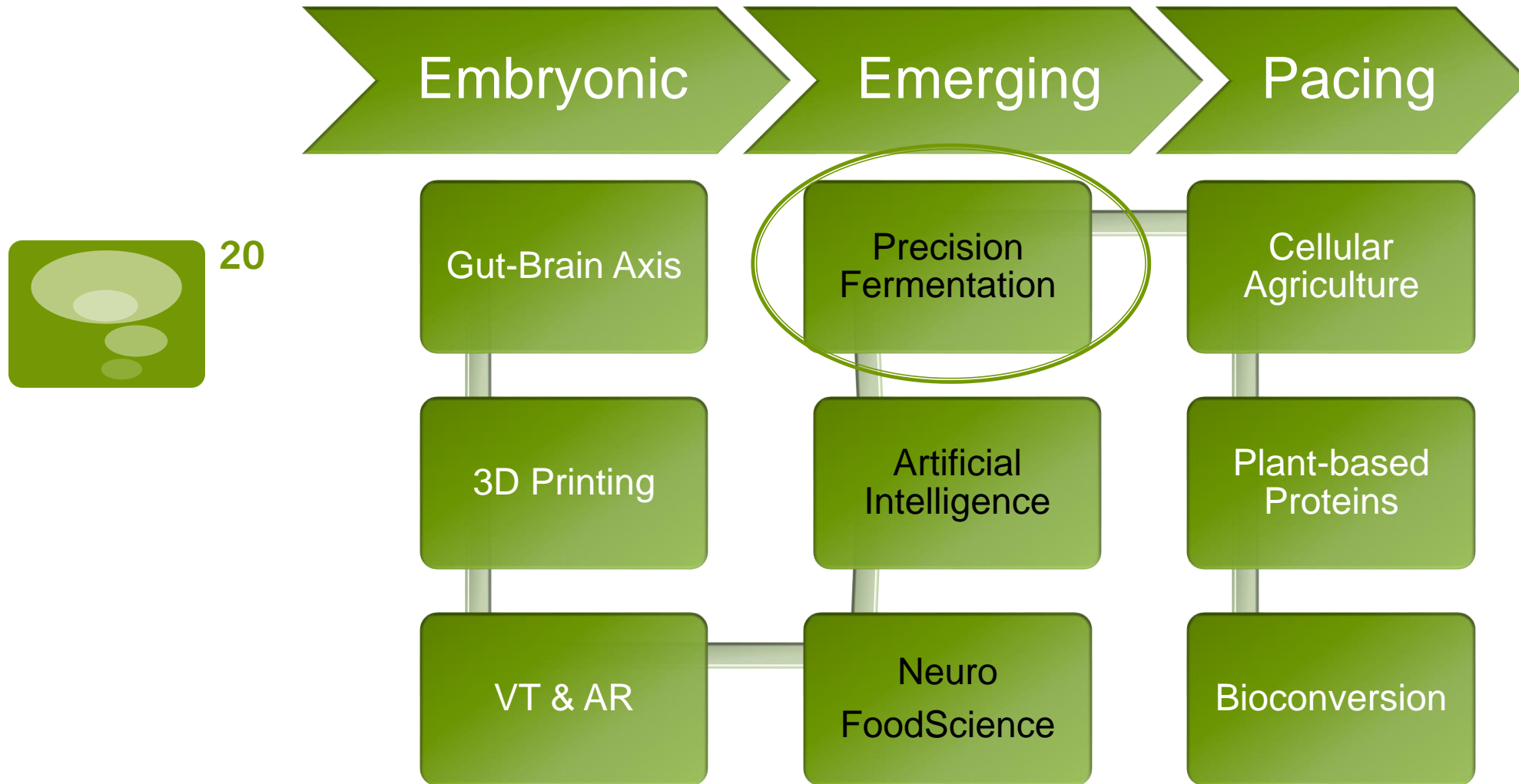
- Features: 4 types
  1. Reactive machines
  2. Limited memory
  3. Theory of mind
  4. Self aware
- Benefits:
  - Faster
  - Better
  - Cheaper
- Challenges:
  - Training data
  - Risks

# Artificial Intelligence: What can we in food R&D do about it? (W2O, 2023)

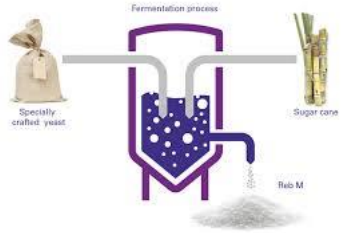


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# Precision Fermentation (W2O, 2023)



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**What is it?**  
**What does it do?**  
**How ?**

- High yield & single- compound fermentation
- Raw material= mostly glucose from sugarcane or corn starch
- Microbe= GMO yeast and other microbes
- Target= high value but rare food ingredients previously not economically feasible as plant/animal extracts
- 136 precision fermentation companies (GFI, 2022)

**What are the Features & Benefits?**

- Features: Food ingredients, all rare and high value
- Benefits:
  - Cheaper
  - Unlimited supply
  - Sustainable
- Challenges:
  - Scale up
  - Cost
  - Acceptance

# Precision Fermentation: What are the target food ingredients so far? (W2O, 2023)



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Color, Fat, HMO

Sweeteners

RM, M-V

Others

Precision Fermentation

Flavors

Meat, Egg, Dairy

Proteins

Vanillin, Nootkatone, Heme



EVOLVA



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# So-What= Points+ Meanings+ To Do

## So-What? (W2O, 2023)



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What are the points?

1. NeuroFoodScience is the foundation for clean label sugar reduction, salt reduction, and multisensory experience.
2. Artificial Intelligence makes food innovation and renovation better, faster and cheaper
2. Precision Fermentation is the enabling technology for making rare and high value food ingredients



What do they mean?

1. Emerging technologies from neighboring industry are game changers shaping the future of food industry



What can we do about them?

1. Understand, adopt, and embrace
2. Make better foods that are not only better for human lives but also for a better planet





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Questions?