UCD Institute of Food & Health

Genetic Variation in Chemosensory Receptors: Linking Genetics and Food Choice

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Overview

- Taste as a driver of food choice
- Taste & flavour
- Genetic differences in taste and smell
- Variations linked to food preferences
- Considerations for the consumer

TASTE : Can influence our food choice

- **Personal food values**
- **Used to make choices**
- **Influenced over life course**
- **Can vary from person to person and within eating situation**

- **Taste : important food-related value**

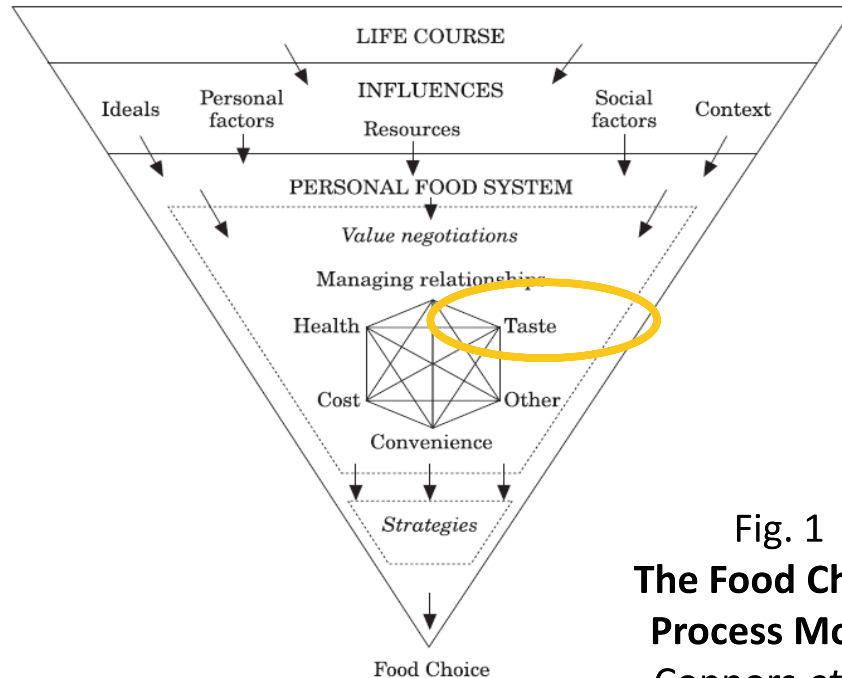
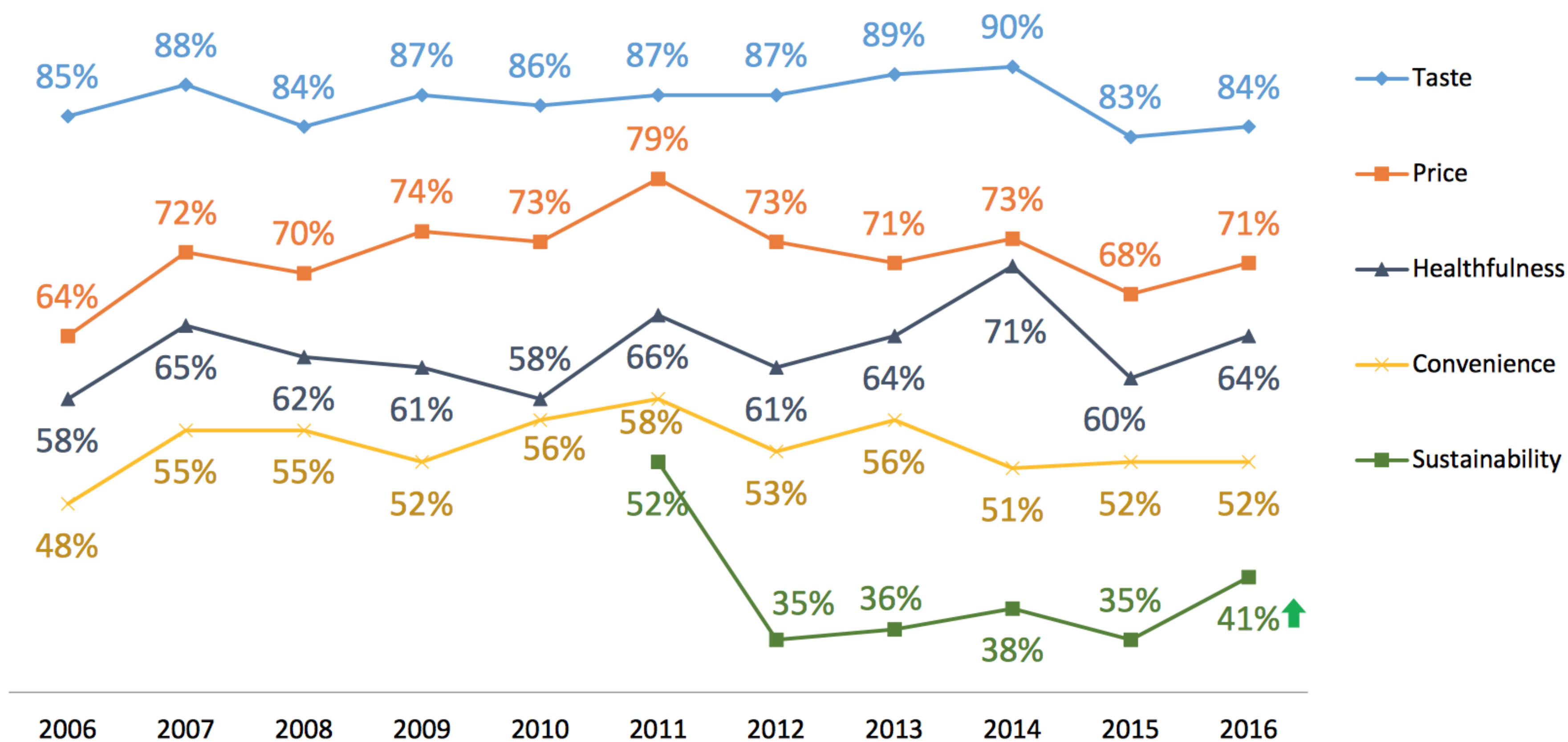


Fig. 1
The Food Choice Process Model
Connors *et al.,* (2001)



2016 n=1,003

Arrows indicate significant (.95 level) differences vs. 2015.

International Food Information Council Foundation

2016 Food and Health Survey

Taste – consistently no.1 factor in purchasing for last decade

What is taste?

- What we perceive in absence of smell

Also chemosensations:

- \- Burning (TRPV1)
- \- Cooling (TRPM8)

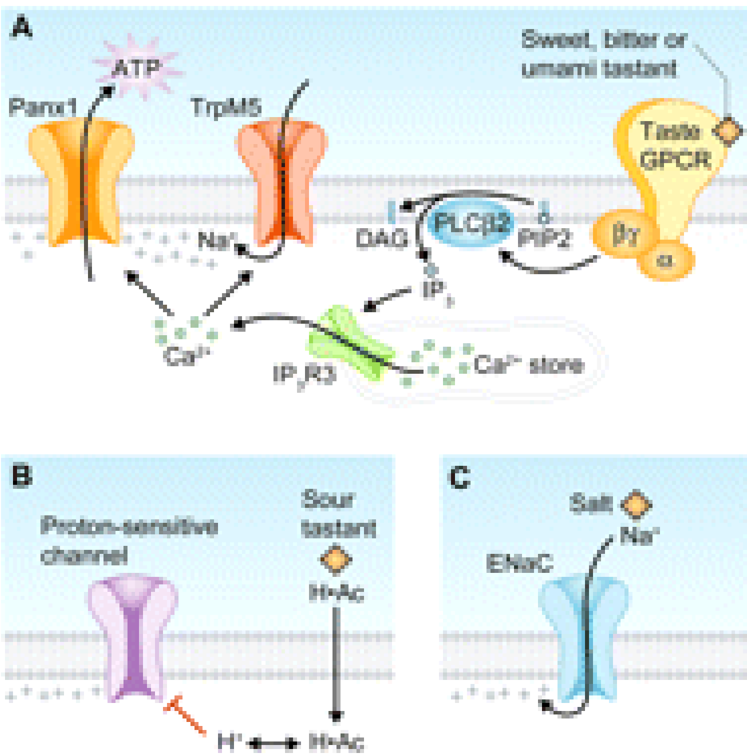


Figure 3. Taste transduction in (A) bitter, sweet and umami (B) Sour and (c) Salty taste

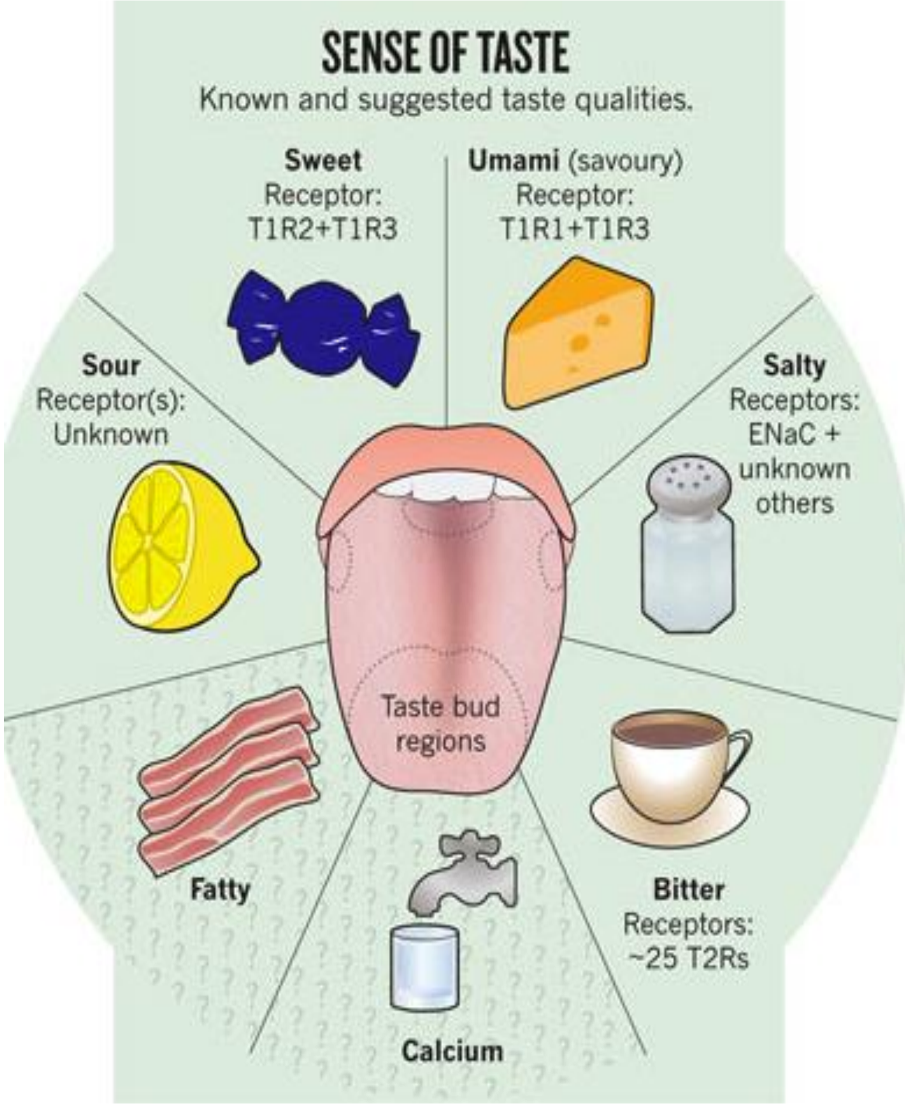
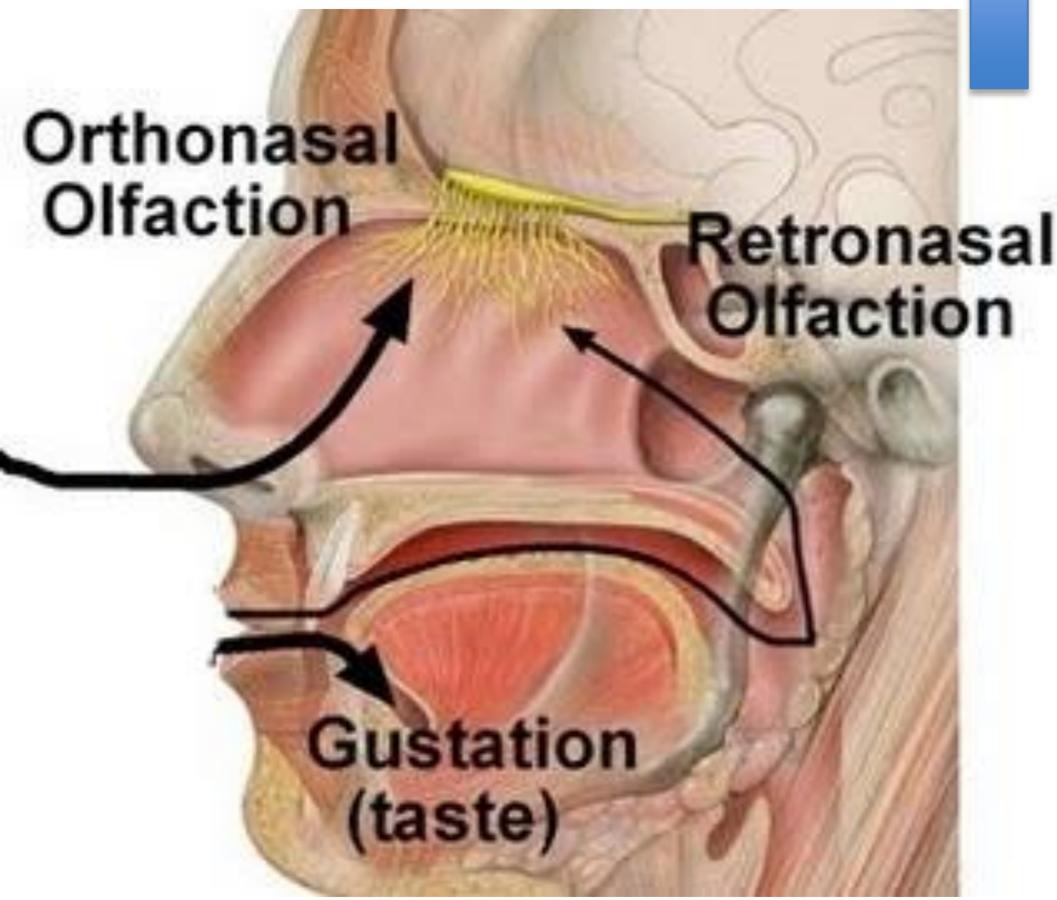
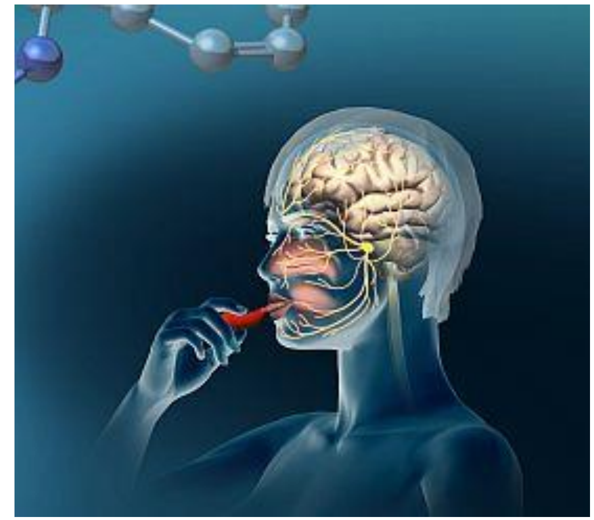


Figure 4. Taste receptors for prototypical tastes

Flavour: A multisensory perception



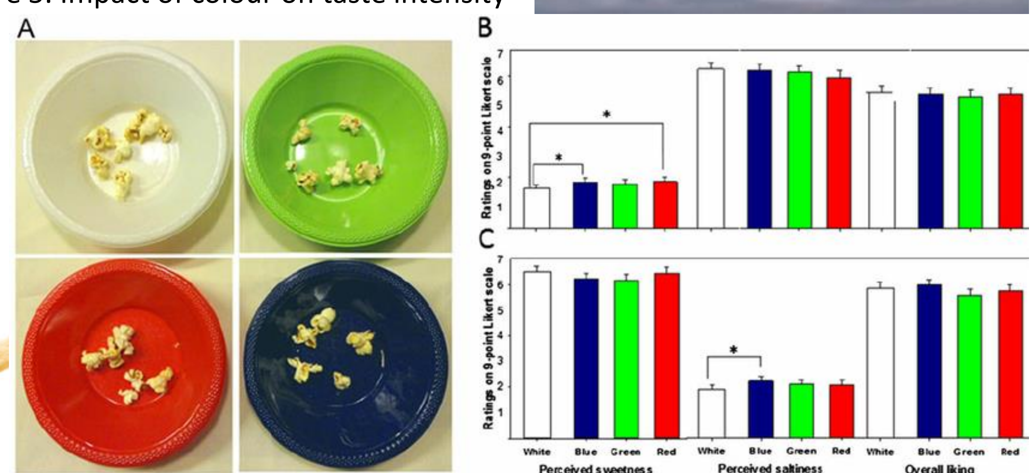


- taste
- smell
- trigeminal sensation

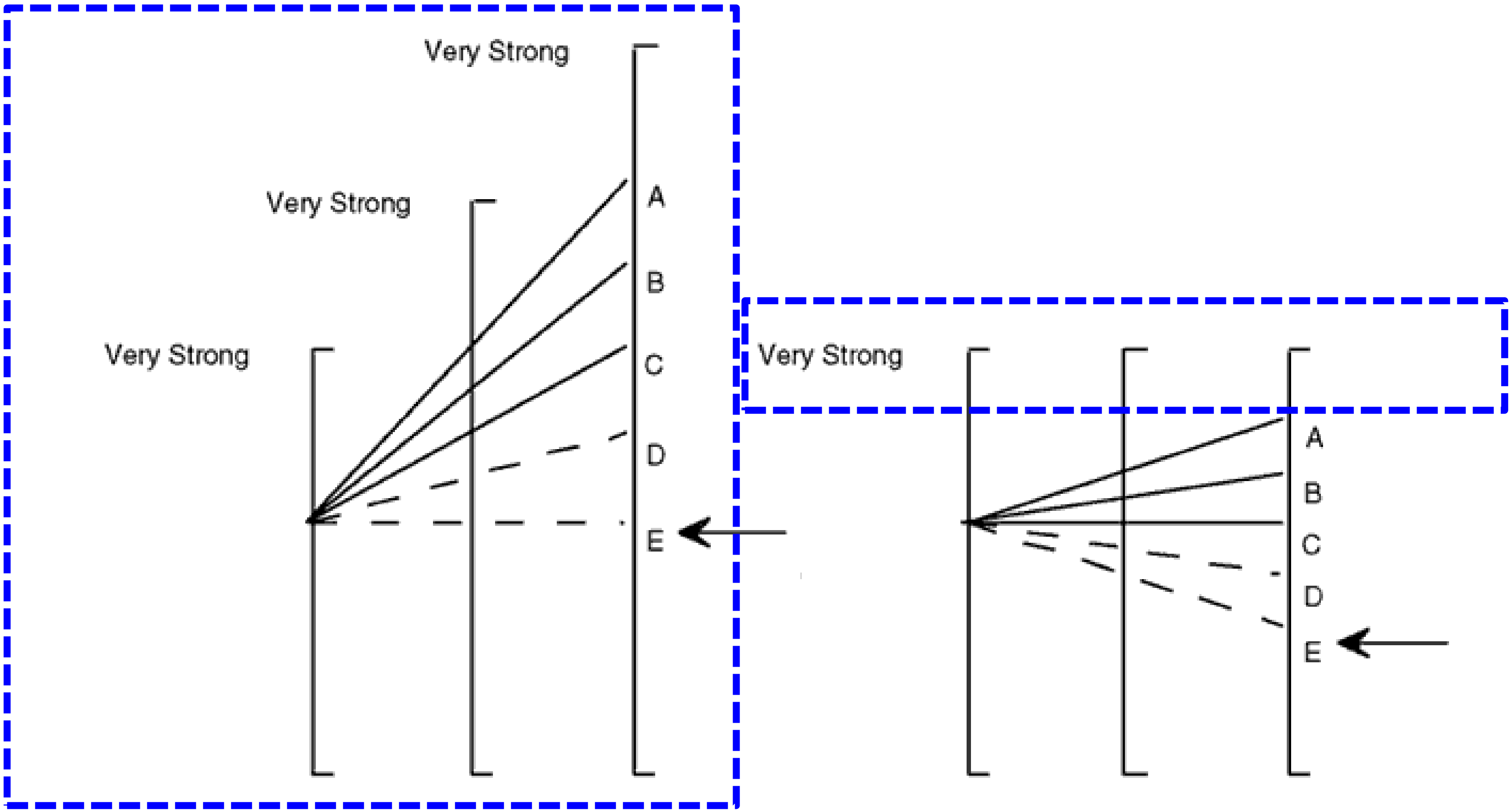
Flavour – a multisensory perception

- Taste
- Smell
- Trigeminal sensation
- Vision, sound

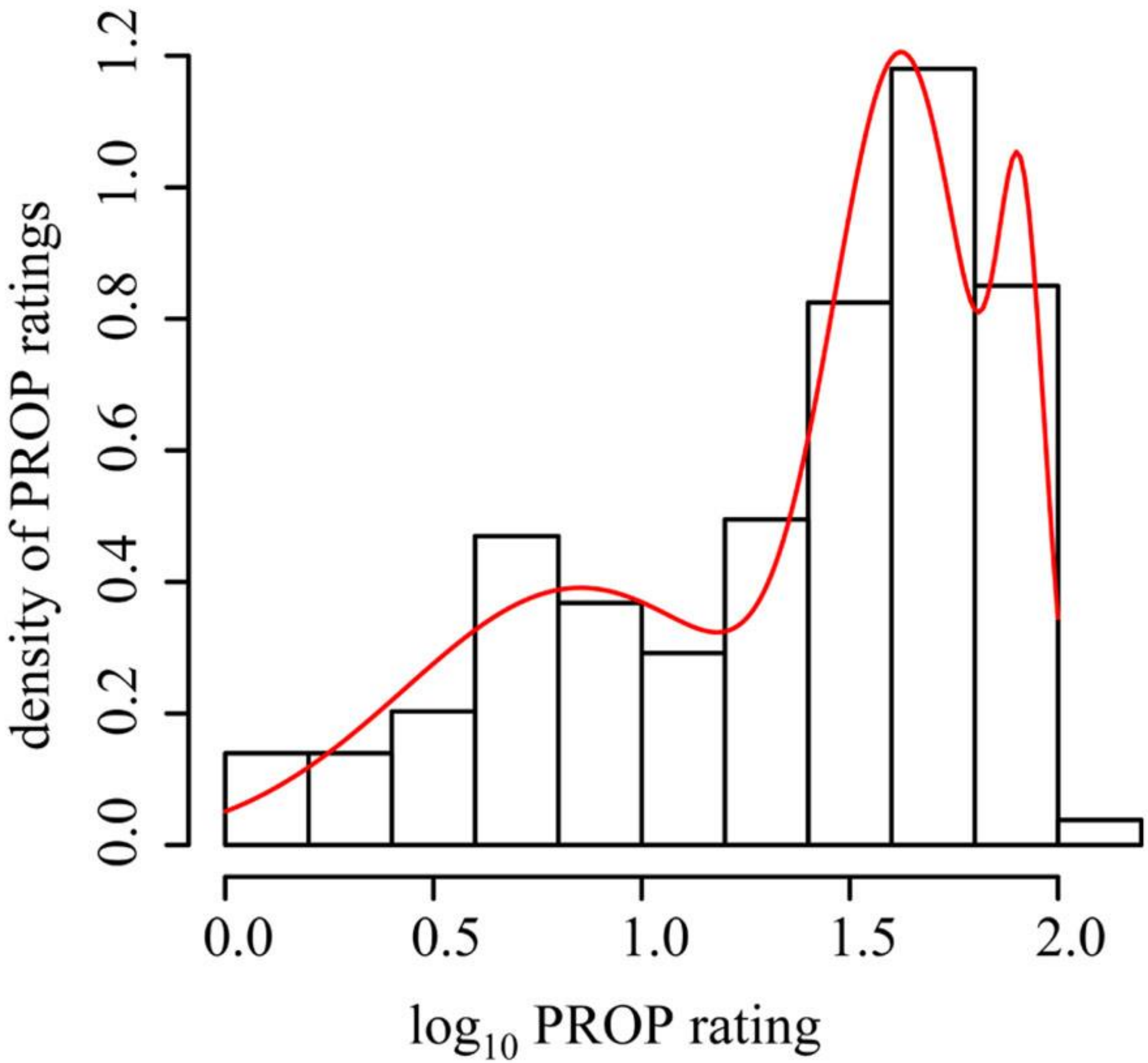
Figure 5. Impact of colour on taste intensity



Individual Differences in Perception



- Classic example: Bi-modal distribution of PROP / PTC intensity



Irish children: Supertasters ½ as likely to have tried green veg

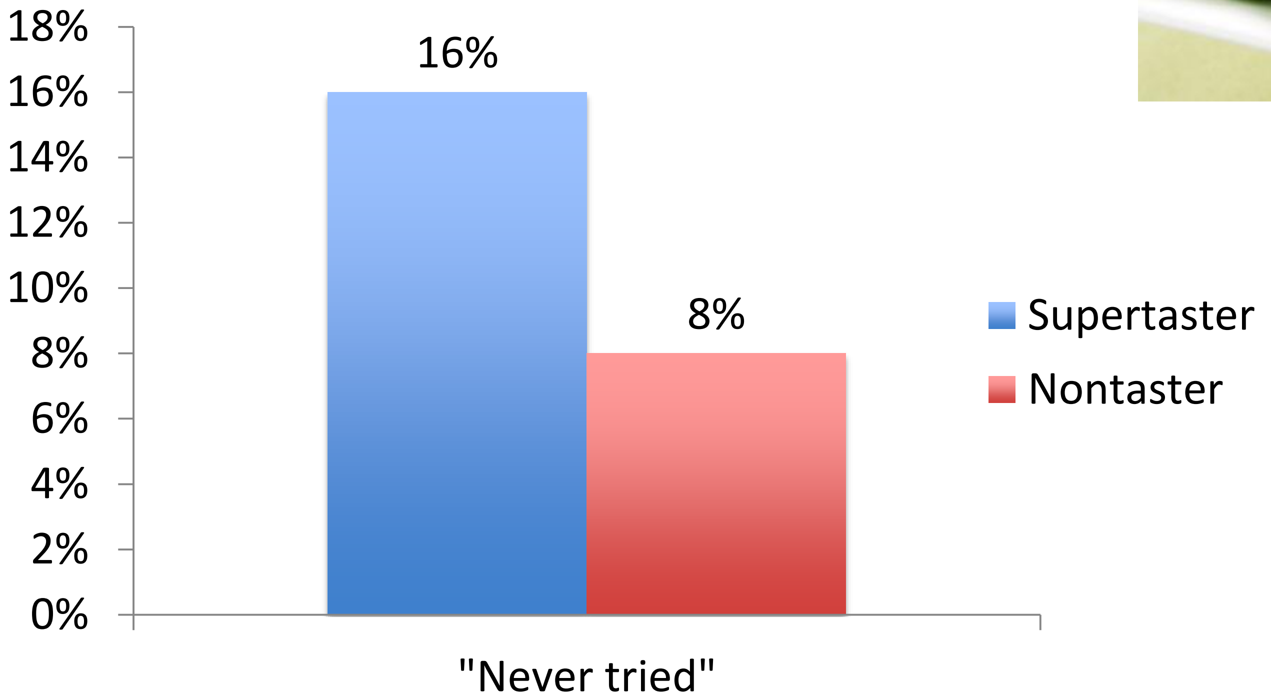
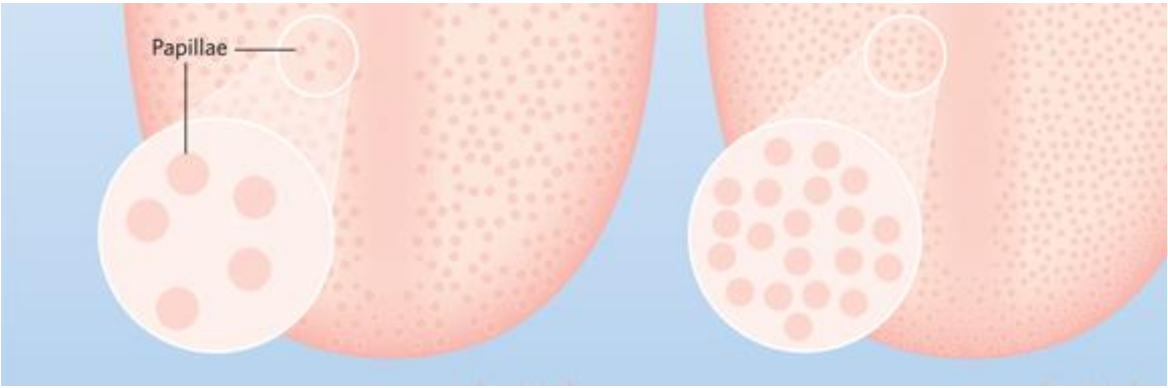


Fig. 6. Data from Feeney et al, (2014) Genetic and environmental influences on liking and reported intakes of vegetables in Irish Children- Food quality and Preference

Supertaster tongue? Probably not….



Supertaster tongue doesn't seem to exist…

(Feeney & Hayes, Chemical Senses, 2014; Feeney & Hayes, Chemosensory. Percept, 2014)

Females have a greater density of FP than males

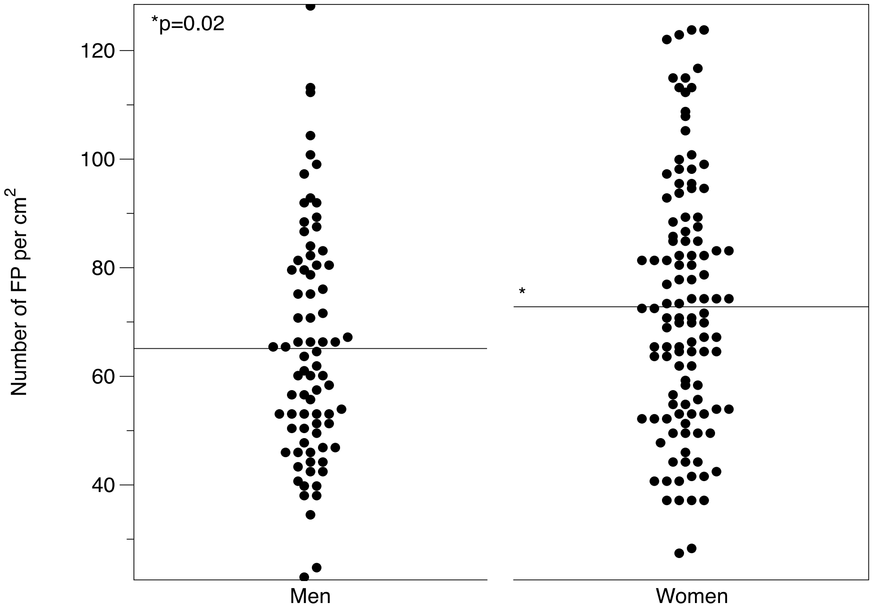


Fig. 7. Feeney and Hayes, 2014, *Chemosensory Perception.*

Genetic variation in bitter taste…

- **Now known – 25-30 bitter taste genes**
- TAS2R38 discovered in 2003
- Encodes PTC receptor
- Also binds other N-C=S compounds
- Each codes for a receptor
- Receptors may bind multiple compounds

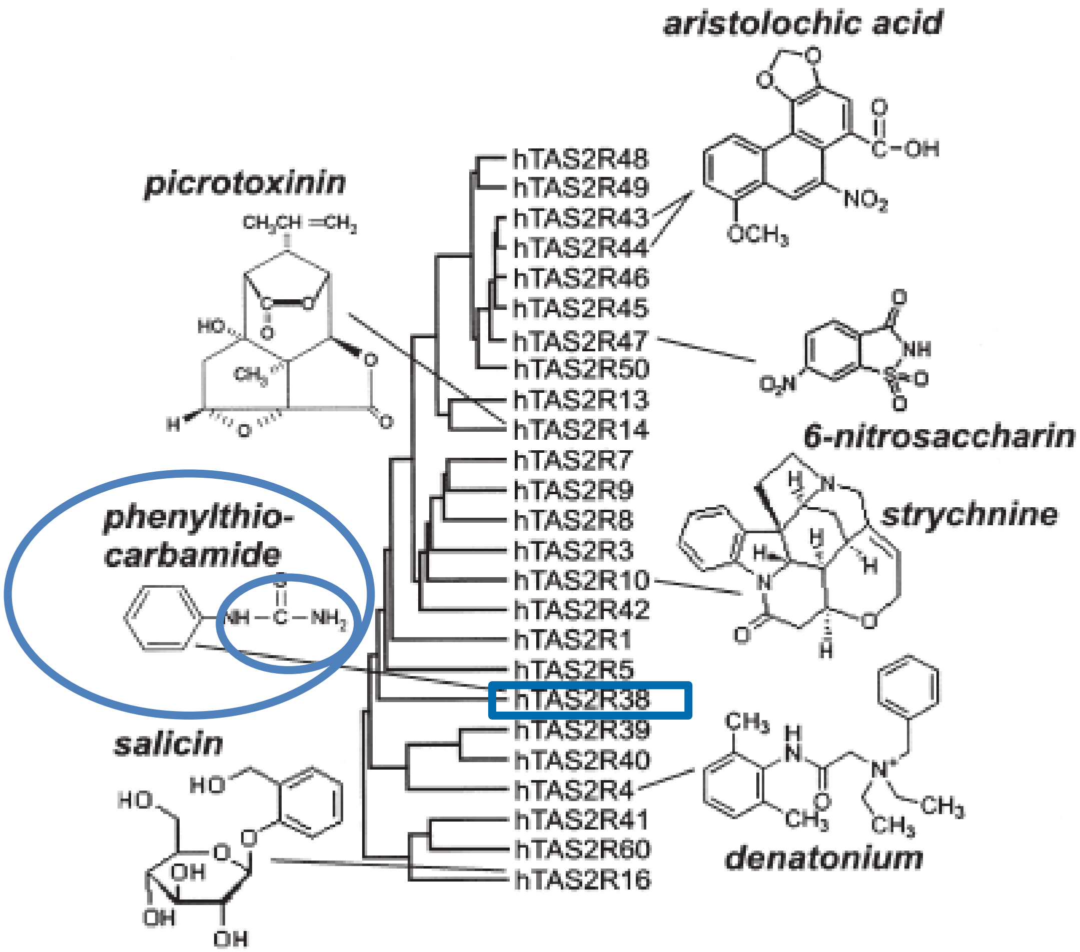


Figure 8. Phylogenetic tree of TAS2R gene family

(Adapted from Behrens & Meyerhof, 2006)

Bitter taste receptors - GCPRs

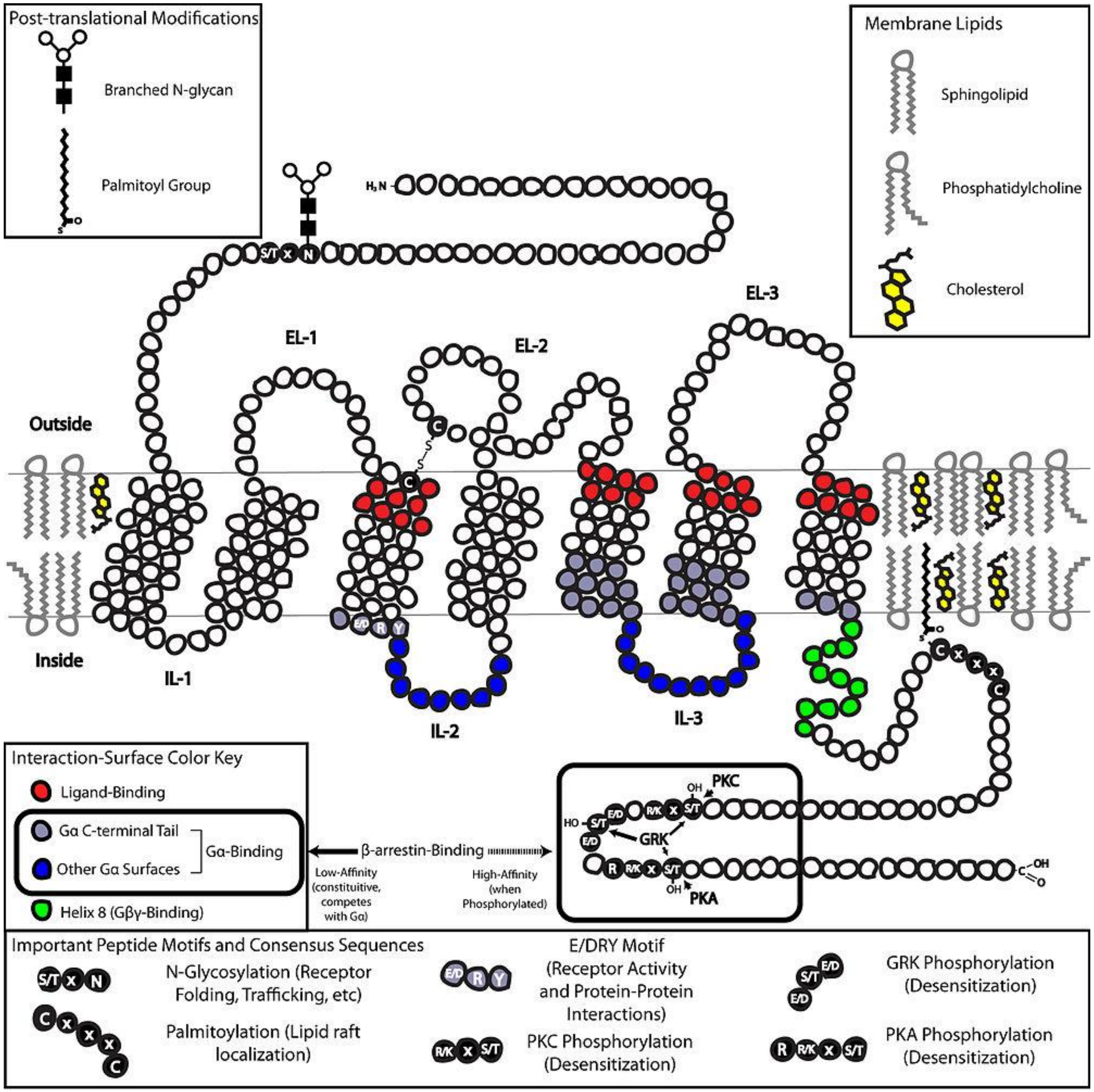


Figure 9. Typical structure of GCPRs

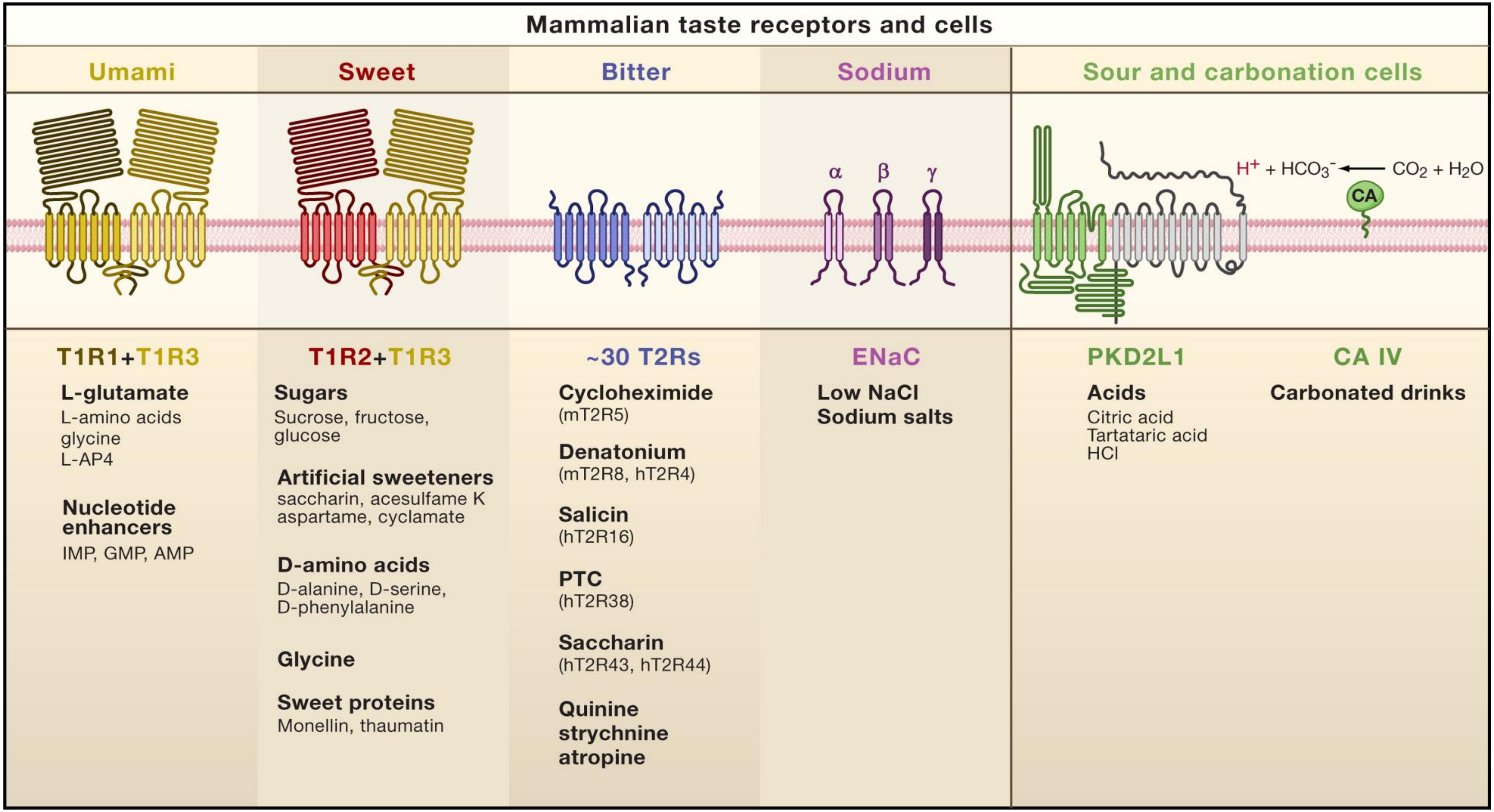


Figure 10. TRC in mammals and their ligands, adapted from Yarmonlinsky et al, (2009) Cell

Genetic variation in umami and sweet receptor genes

Gene	SNP	Association and possible mechanism, if known	Taste quality affected
TAS1R1	A372T[(30]	T associated with high sensitivity. Mechanism unknown	Umami
	G1114A[(95]	A associated with high sensitivity. Mechanism unknown	Umami
	C329T[(95]	T associated with low sensitivity. Mechanism unknown	Umami
TAS1R3	R757C[(30,]	C associated with lower sensitivity. Mechanism unknown	Umami
	R247H[(30)]	H associated with increased sensitivity. Possibly influences binding with L-glutamate resulting in stronger activation of taste system.	Umami
	A5T[(43]	A associated with heightened perception.	Umami
	C2269T[(95]	T more frequent in nontasters. Mechanism unknown	Umami
	C1266T[(41]	T alleles result in reduced promoter activity	Sweet
	C1572T[(41]	T alleles also result in reduced promoter activity in this mutation	Sweet

Table 1. Known SNP associations with umami and sweet perception in the TAS1R gene family, adapted from Feeney *et al.*, *(*2010)

Taste genetics – may affect coffee intake

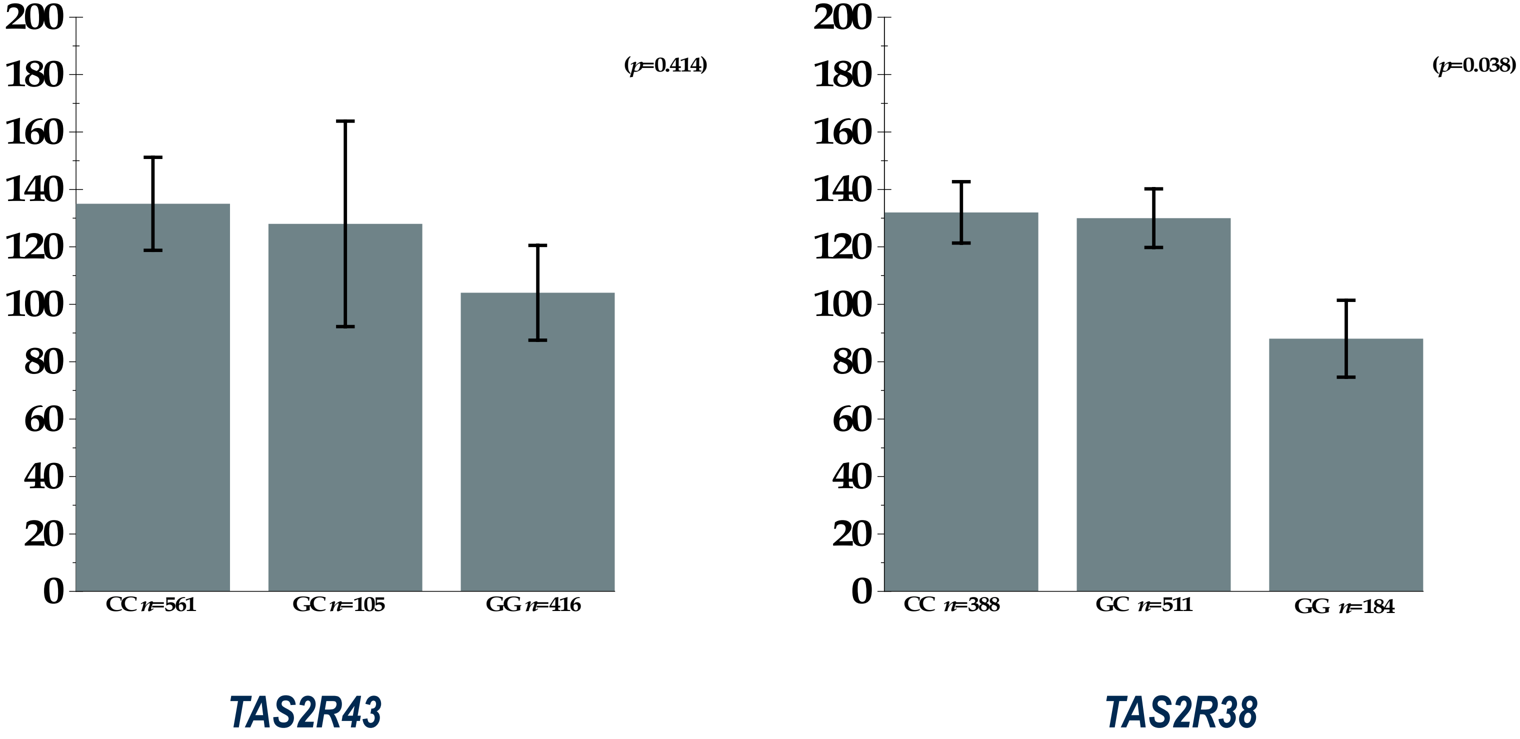


Fig. 11. Mean daily coffee intake (ml/day) across variations of TAS2R43, which responds to caffeine (left) and TAS2R38, which responds to PTC (right). ***Davis and Feeney (2015), presented at Pangborn, Sweden***

Taste genetics: Can affect sweetener preference

Chem. Senses 38: 379–389, 2013

doi:10.1093/chemse/bjt017
Advance Access publication April 17, 2013

Bitterness of the Non-nutritive Sweetener Acesulfame Potassium Varies With Polymorphisms in *TAS2R9* and *TAS2R31*

Alissa L. Allen[1,2], John E. McGeary[3–5], Valerie S. Knopik[4,5] and John E. Hayes[1,2]

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Odor receptors are also implicated in food preferences..

Table 2. Functional SNPs in chemosensory genes

SNP ID/ Position	Gene	Region	Chemosensation	Reference	Liking / Intake
R88W, T133M	OR7D4		Androstenone odor, androstadionone odor	Keller (2007); Knaapilla	May affect acceptance of boar tainted pork
Not actually a SNP – the non-functional allele is a pseudogene	OR11H7P	*Coding region*	Isovaleric acid	Menashe, (2007)	
rs7277172	OR4N5		?		Cilantro preference
rs427871	TAS2R1		Bitter receptor		Cilantro preference

Adapted from Hayes, Feeney and Allen (2013) Food Quality and Preference 30; 202–216

Ihatecilantro.com

Odor receptors….

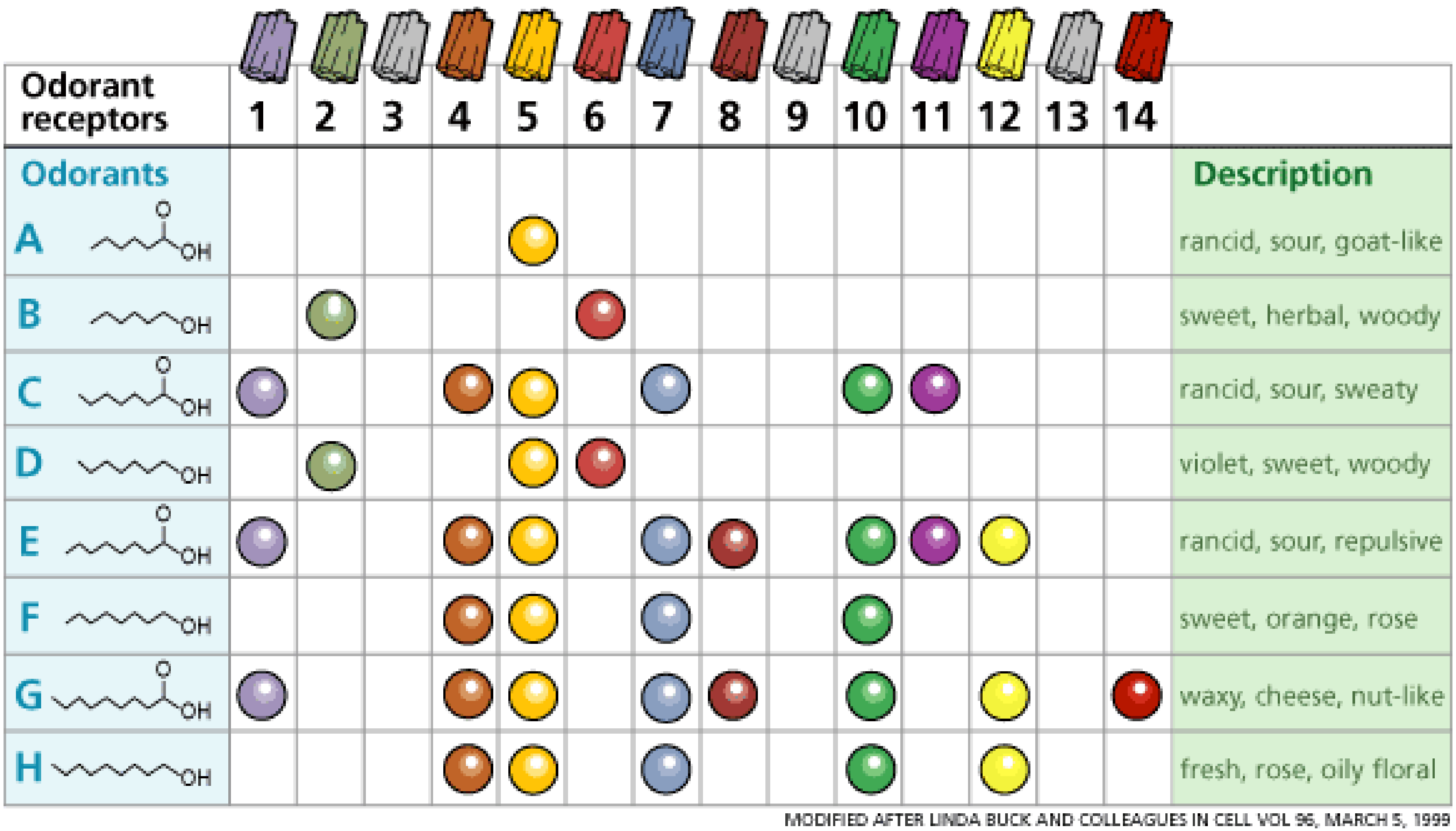
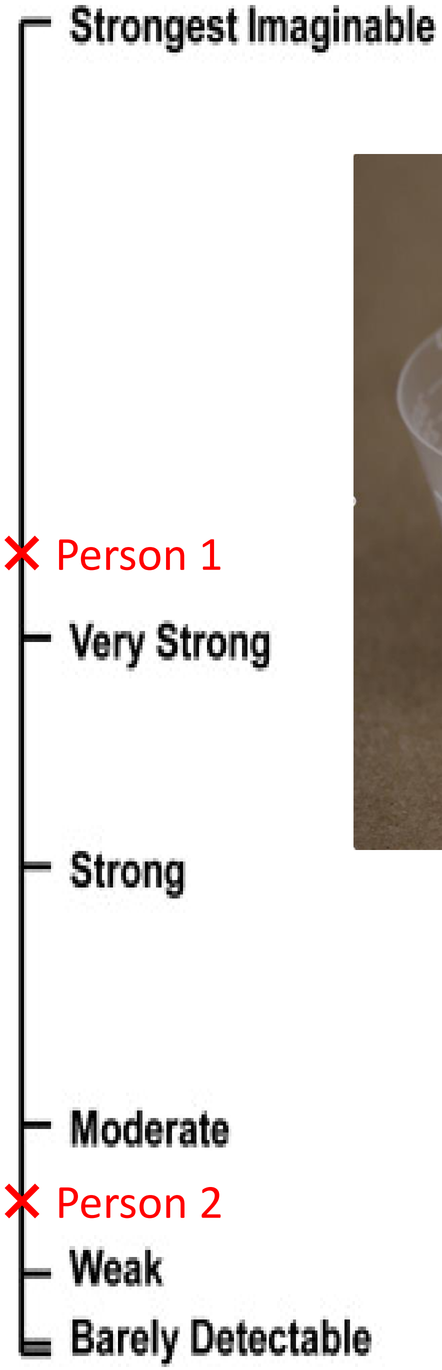
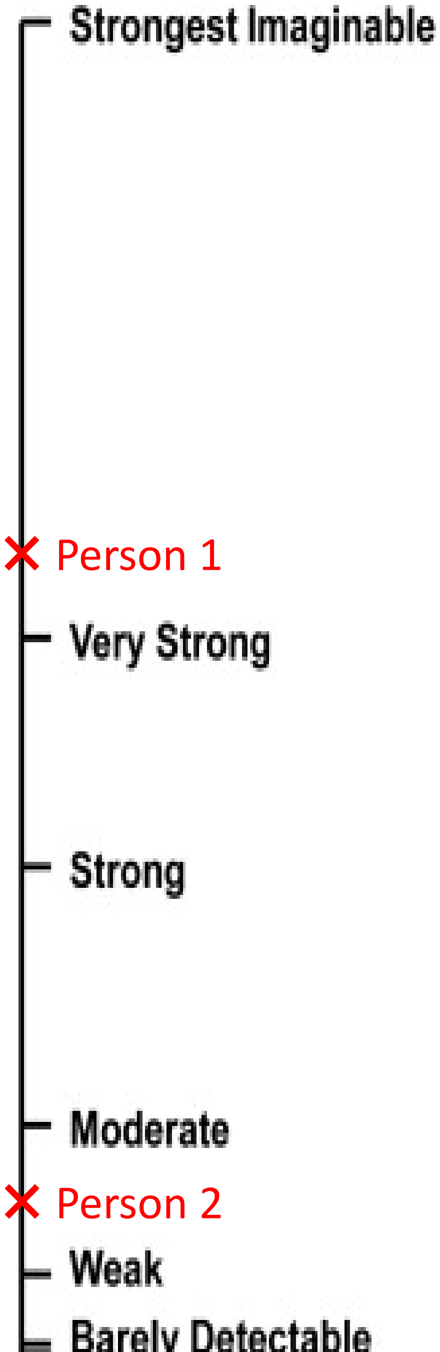


Figure 12. Schematic of odor perception


Strongest Imaginable
Person 1
Very Strong
Strong
Moderate
Person 2
Weak
Barely Detectable


736
277
347

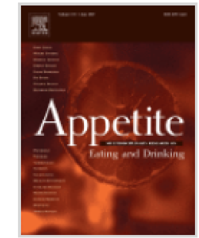


Becomes more complicated with real beverages & foods- interaction of many compounds and tastes:

Genetic differences and diet quality

Appetite

Volume 113, 1 June 2017, Pages 116–123



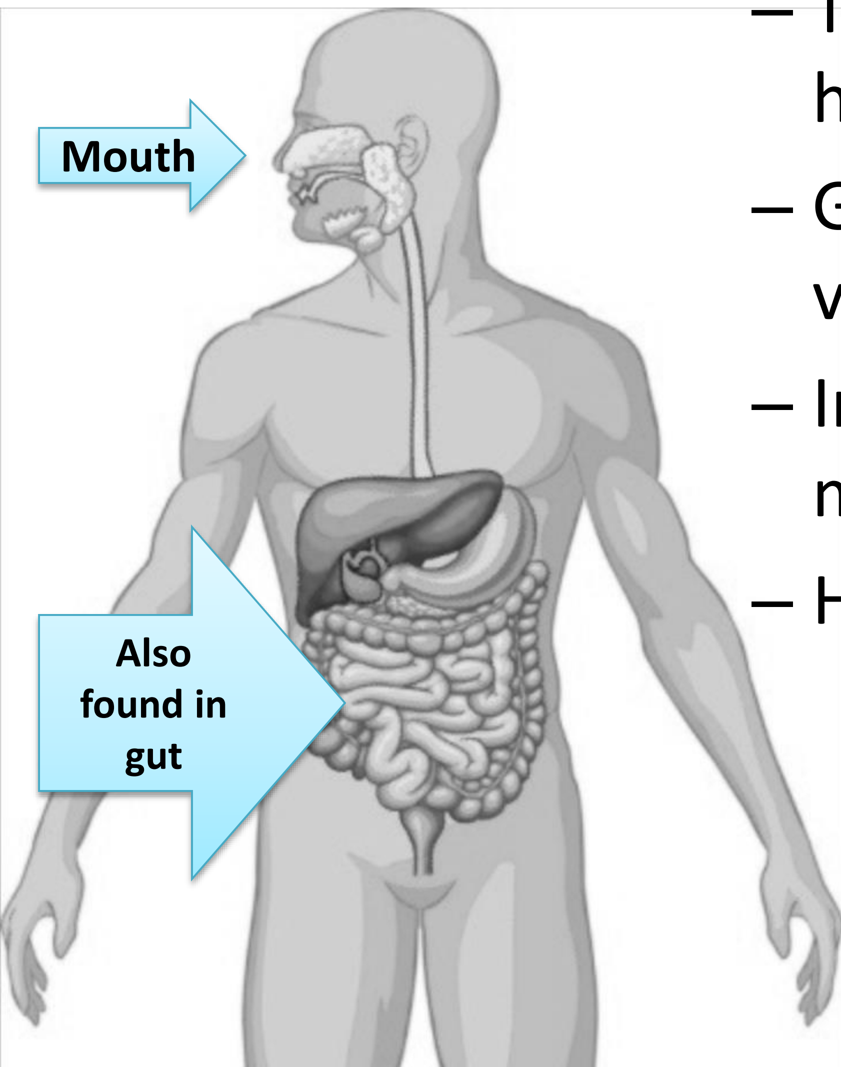
Suprathreshold measures of taste perception in children - Association with dietary quality and body weight

Emma L. Feeney[a], , Sinead A. O'Brien[a], Amalia G.M. Scannell[b], Anne Markey[b], Eileen R. Gibney[a]

Show more

https://doi.org/10.1016/j.appet.2017.02.026

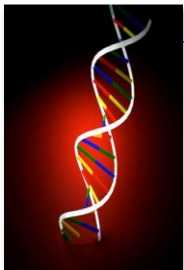
Taste receptors also found in the gut



– TAS2R38 - association with glucose homeostasis
– Gnat3 is involved in sweet taste variations - sweet perception
– Implicated in GWAS study of metabolic syndrome
– How? Interaction / signalling in gut?

(Fushan et al, Chem senses, 2010; Feeney *et al* 2013, Nutrient Sensing in the Gut, Hamburg)

Challenges: Complexity of human perception



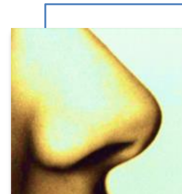
Separating genetic variation from other taste intensity influences?

Modeling the interaction of receptors with real foods?

Modeling all known genetic variations in chemoreceptors together to predict taste perception?

Relating this to food liking?

Modeling signaling in gut?



These are just taste -Odor receptors (flavour)– over 400 known – predicting interaction??- Machine learning ?

***Summary – taste is important*!**

- Taste is a key driver of food choices
- Taste & odour perception can vary considerably
- **Individual differences in perception – a key consideration**
  - Affects food choice, liking, drives market segmentation
  - Important to know your data, and your target group
  - Sometimes choices may be necessary