Umami in wine

Gabriel Lepousez, PhD
Perception & Memory Lab, Institut Pasteur, Paris
Ecole du Nez, Paris
Email : gabriel.lepousez@pasteur.fr

WINE TASTING: A MULTI-SENSORY PROCESS

“MINERALITY” IN WINE : A MULTI-SENSORY DESCRIPTOR

Starkenmann et al. 2016 Journ Agri Food Sci
Tominaga et al. 2003 Journ Agri Food Sci
Parr et al., 2015 FQP
Heymann et al., 2014 JSS

“Mineral” aromas

Absence of fruity/sweet aromas

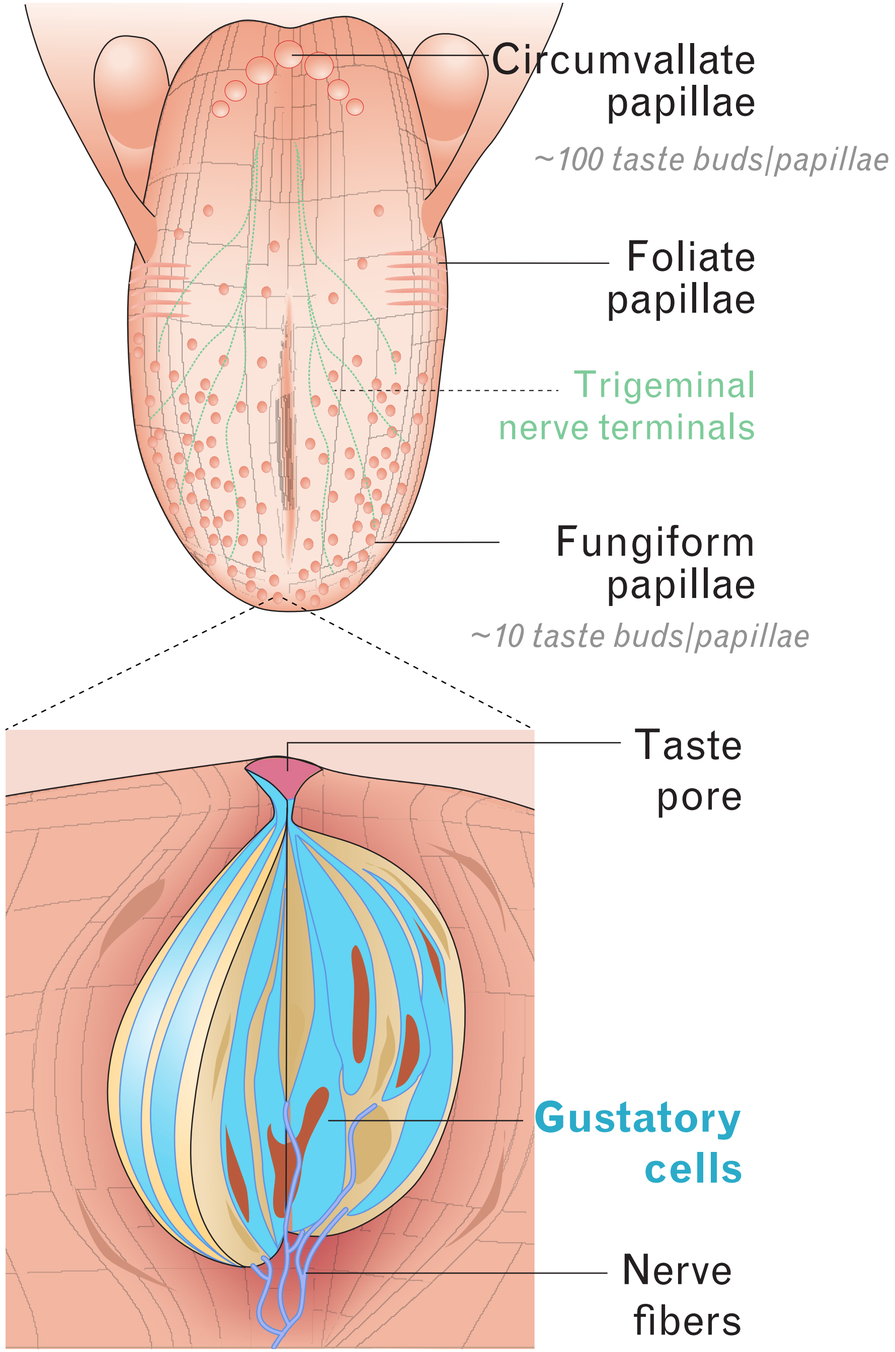
Mouthfeels

Salinity

Acidity

NB : “Acid”, from latin *acere* = sharp, pointed, harsh

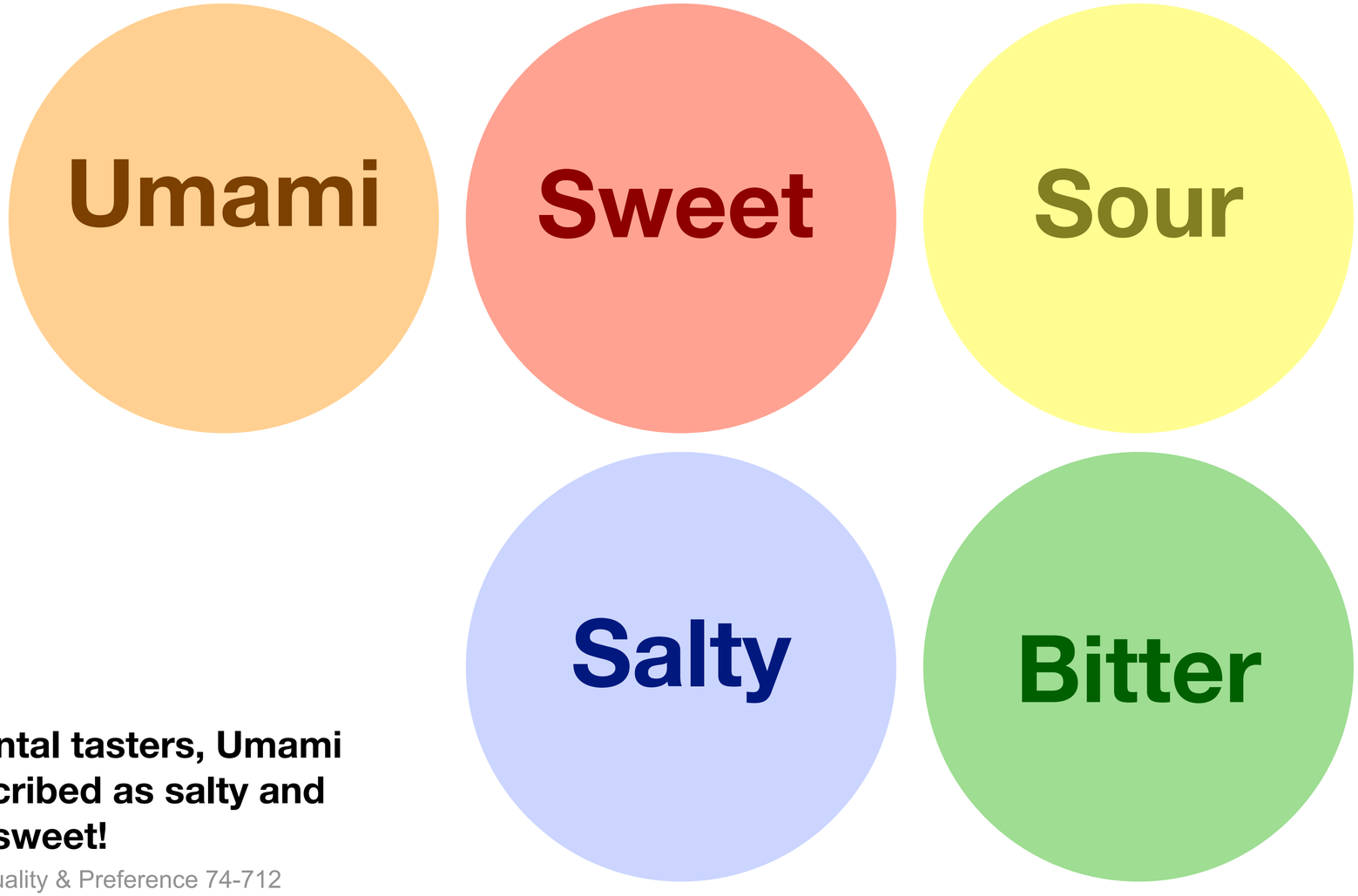
GUSTATORY CELLS IN THE MOUTH



~1000-10000 taste buds
~50-100 gustatory cells per taste bud

Gustatory cells regenerate
(~10-20days turn-over) !!!

THE 5 BASIC TASTES



For European/occidental tasters, Umami compounds are described as salty and slightly sweet!

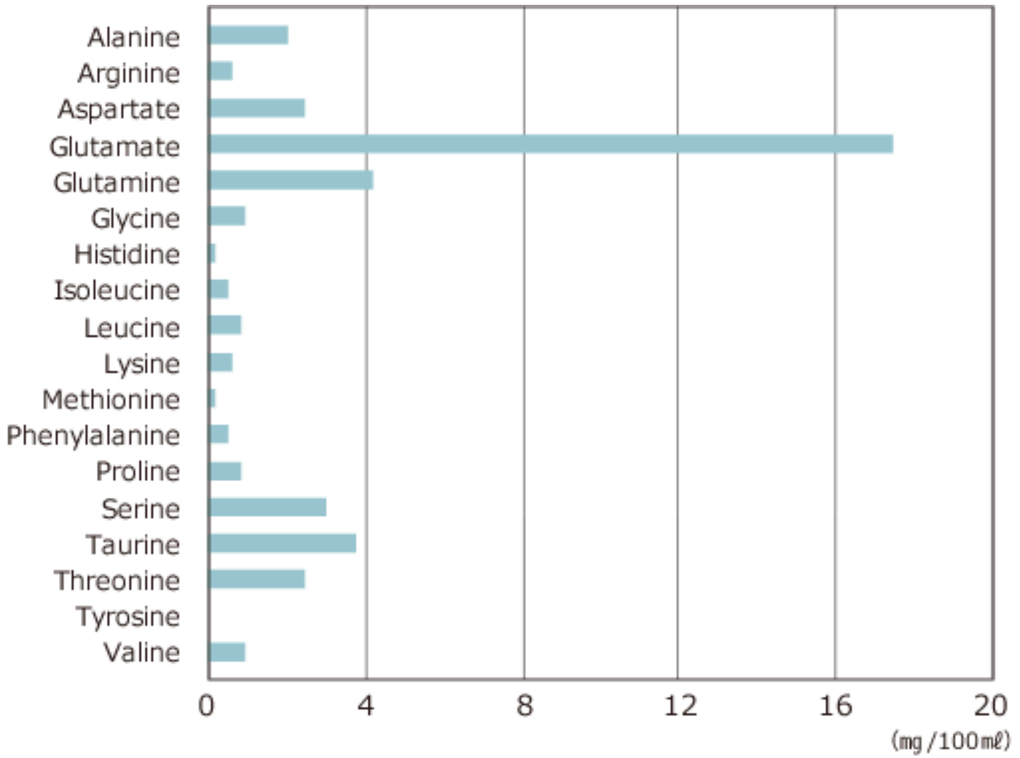
Cecchini et al., 2019 Food Quality & Preference 74-712
Iannilli et al., 2020 Data in Brief

Umami

One receptor (T1R1/T1R3) for :

- Amino acids : Glutamate, aspartate
- Nucleotides : IMP, GMP

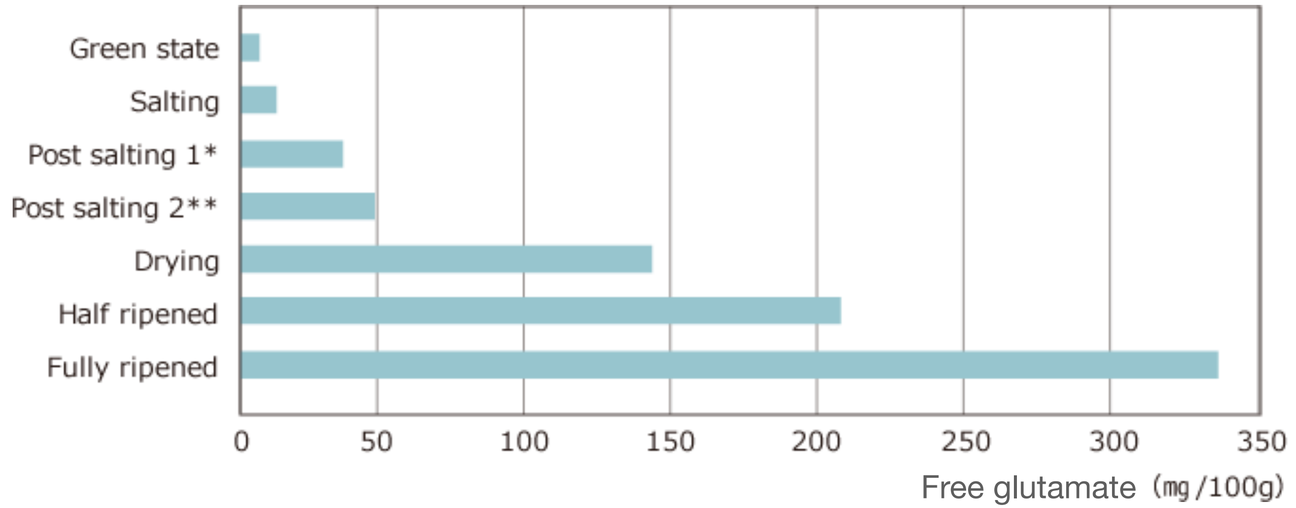
Amino acids content in human breast milk



©Umami Information Center (Cario Agostini et al., 2000)

Glutamate release needs protein hydrolysis (fermentation, maturation, cooking)

Exemple of glutamate release during ham curing



Umami

One receptor (T1R1/T1R3) for :

- Amino acids : Glutamate, aspartate
- Nucleotides : IMP, GMP
- Fermentation-derived organic acids

Succinic acid (Ma et al., 2020 Food Chem)

- Polyphenols as umami-enhancer compounds?

> Example from tea research : gallic acid, theogallin, myricetin

Kaneko et al., 2006 J. Agric. Food Chem. 54, 2688
Li et al., 2013 Journal of Food and Nutrition Research, 2013, Vol. 1, No. 6, 164

Gyokuro green tea

5 descriptive dimensions of Umami taste :

“Salty/Savory” Persistent Coating Salivating Pleasant

SALIVATION & UMAMI TASTE

Saliva composition

Water (99%)

ions
(calcium, phosphate,
sodium, potassium, bicarbonate)

proteins (~3400)

Bacteria (oral microbiota)

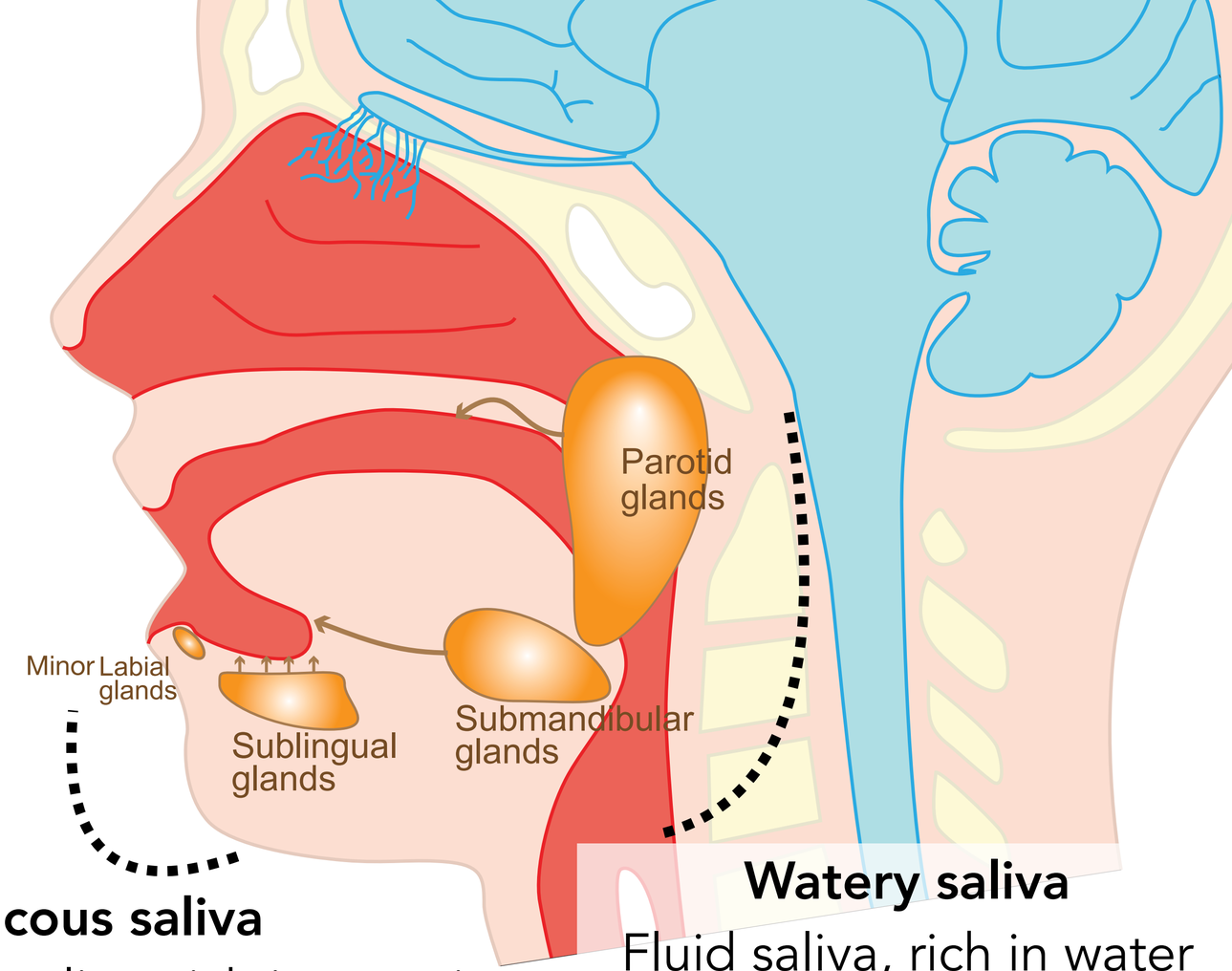
A variable composition

basal: pH 6-7 after stimulation: pH 8

Two types of saliva :

Watery saliva *versus* Mucous saliva

Individual differences (flow, protein content)



Mucous saliva

Thick, coating saliva, rich in proteins

Slow/progressive release by sublingual/labial glands (“front”)

=> Major stimulation by **Umami**

Watery saliva

Fluid saliva, rich in water

Rapid release by parotid/ submandibular glands (“more on the sides”)

=> Major stimulation by **Sour**

Hodson et Linden; Physiology & Behavior 2006
Feron, J Texture Stud. 2019
Carpenter, 2013 Ann Rev Food
Canon et al., 2018 J. Agric. Food Chem.

Synergy
"1+1=3"

Umami in wine

Glutamate
Nucleotides
Succinic acid
Polyphenols?

Fermentation
(0.5-2g/L)

Yeast autolysis

Nutrional stress during fermentation (nitrogen deficit)

Baron & Fiala, 2012 Journal Food Sci
De Klerk & Van Rensburg, 2010
Dienes-Nagy et al., 2020 Oeno One

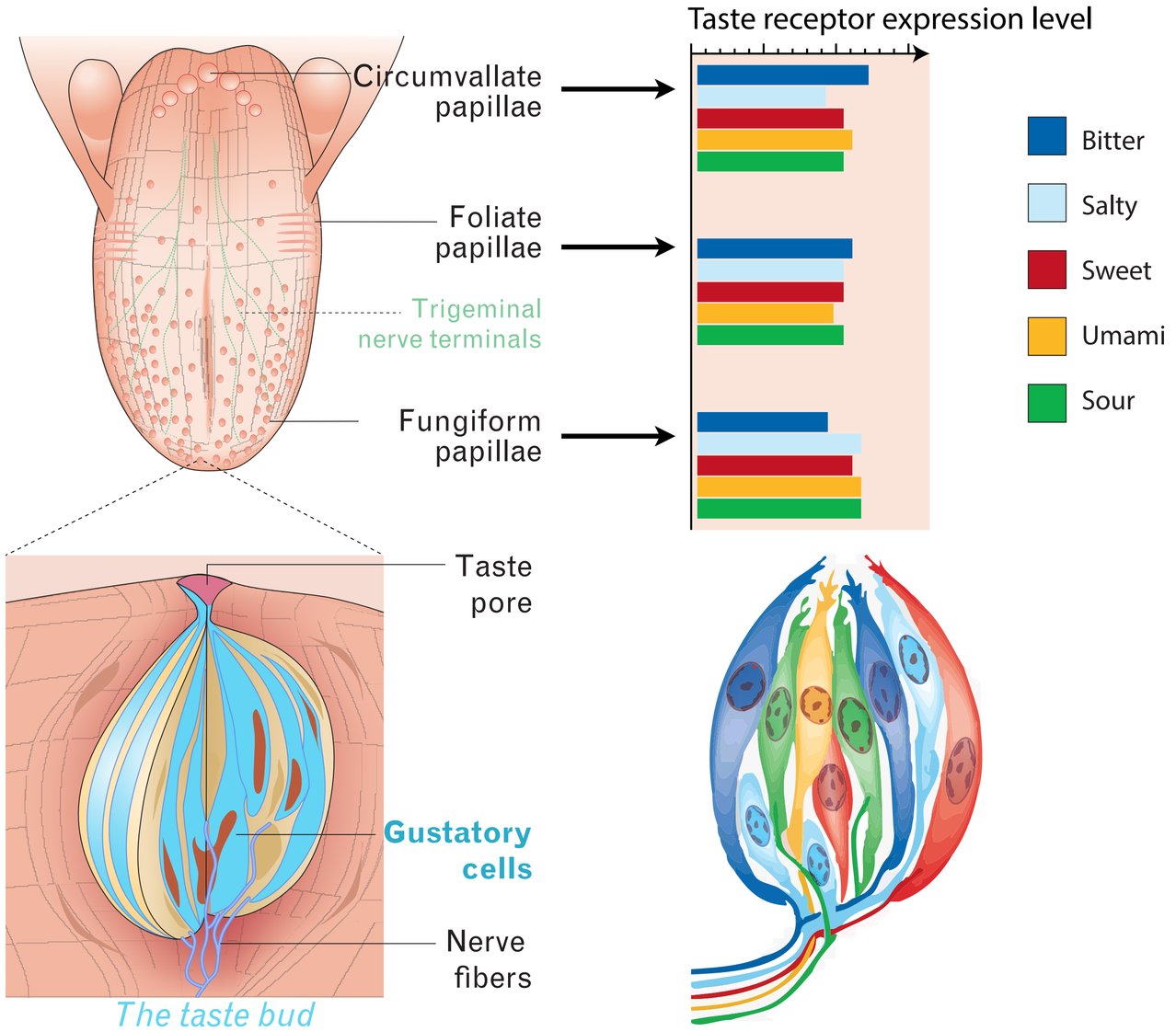
UMAMI IN WINE

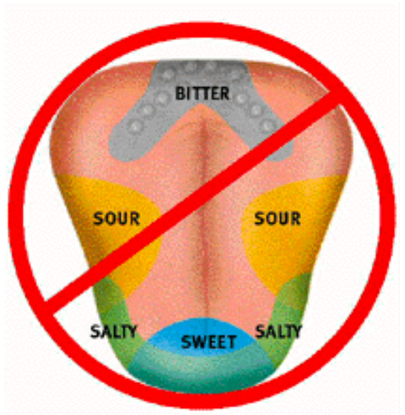
	Sake	White wine	Taste threshold
Alcohol (%)	13 –17	10 – 13	
Extract (g/100ml)	3 – 6	2 – 8	
Glucose (g/100ml)	0.5 – 4.2	0.1 – 3	
Nitrogen (mg/l)	700 – 1900	100 – 900	
Glutamic acid (mg/l)	100 – 250	10 – 90	~50-100 mg/l
Titratable acidity (g/100ml)	0.1 – 0.2	0.5 – 0.9	
pH	4.2 – 4.7	3.0 – 4.1	
Succinic acid (mg/l)	200 – 500	500 – 1500	~300 mg/l
Malic acid (mg/l)	100 – 400	250 – 5000	
Tartaric acid (mg/l)	0	1500 – 4000	
SO_2 (total) (mg/l)	0	– 250	

A Comprehensive Guide to Japanese Sake (Japan Sake and Shochu Makers Association, 2011)

Klosse et al., 2013 Review in Hospitality Management
Vilela et al., 2016 Journal of Food Science & Technology
Vinther Schmidt et al., 2021 Food Chemistry
Vinther Schmidt et al., 2020 Scientific Reports

NO TASTE MAP ON THE TONGUE!

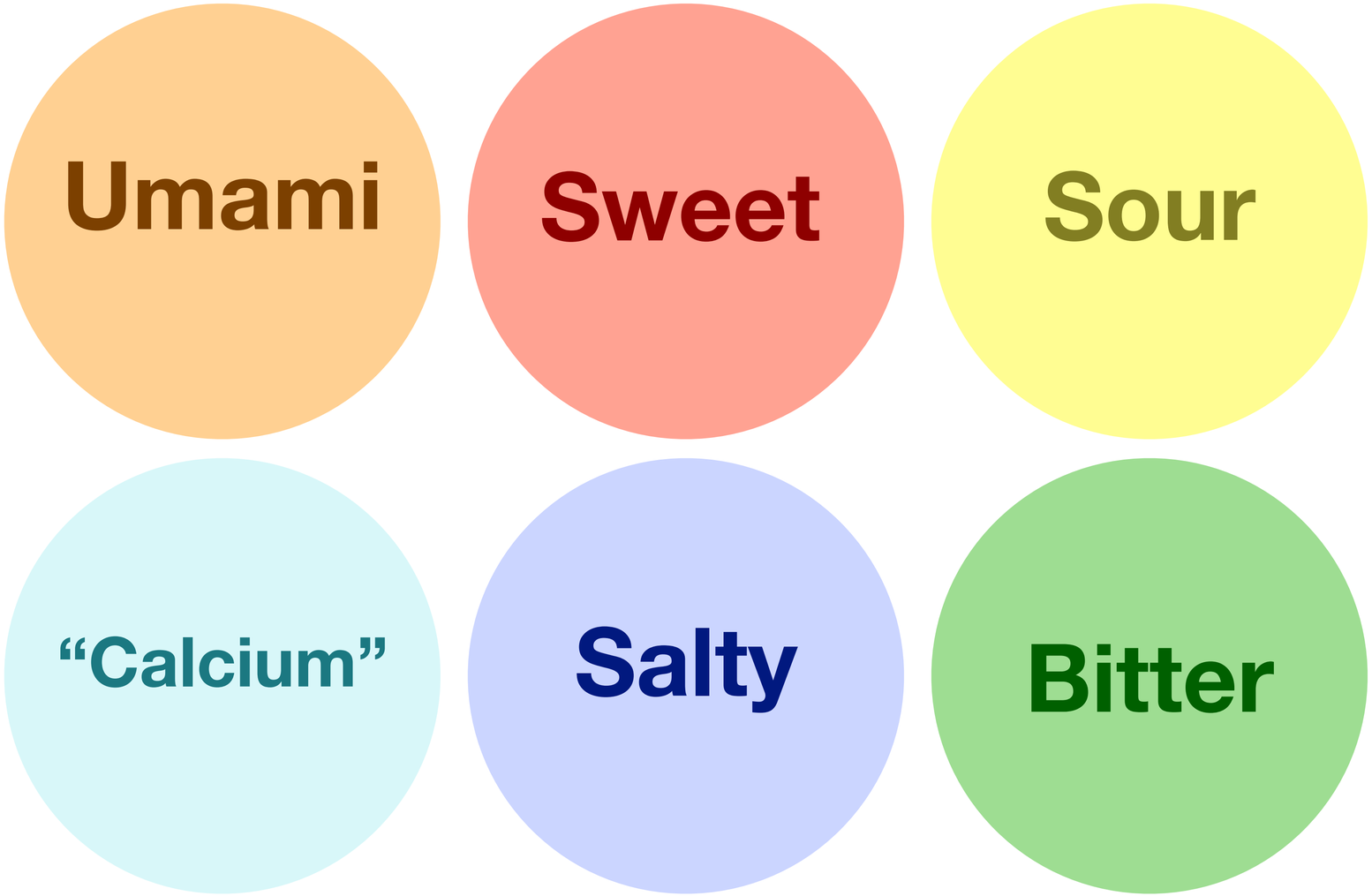




No topographical taste map on the surface of the tongue!

Bartoshuk, 1978, Am. J. Clin. Nutr.
Chandrashekar et al., 2006 Nature
Yarmolinsky et al., 2009 Cell

THE 5 BASIC TASTES + A 6TH TASTE



THE DIFFERENT GUSTATORY FACETS OF SALINITY

Mineral "salinity"

Organic "salinity'

Salty

One receptor for :
Sodium (Na+)
Potassium (K+)

"Calcium"

One receptor for:
Calcium (Ca2+)
Magnésium (Mg2+)

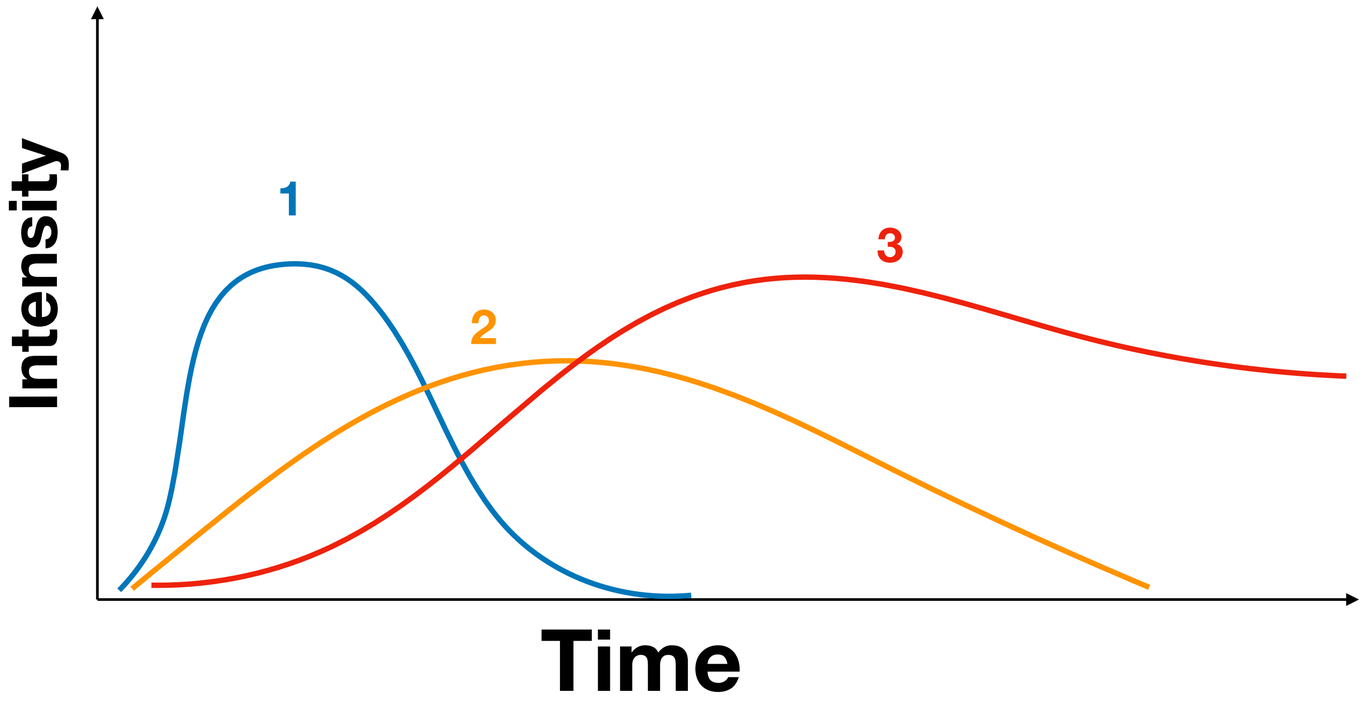
Umami

One receptor for :
Glutamate
Nucleotides
Succinic acid
Polyphenols?

Parameters to discriminate the different forms of salinity :

1) Salivation intensity and localisation
2) Temporality : rising and persistence of salinity
3) Additional tactile perception (linked to salivation)
4) Appreciation

THE DIFFERENT FACETS OF SALINITY



1 : NaCl (2-3g/L)

2 : MgCl (1-2g/L)

3 : Glutamate (1-2g/L)

Additional umami solution : succinic acid (0.5g/L)

CONSTRAINTS ON THE PERCEPTION OF MINERALS IN WINE

	Concentration (mg/L) in saliva	Detection threshold (mg/L)	Max concentration (mg/L) in wine
Calcium	**60**	**100**	**<80-100**
Magnesium	**5**	**25**	**80-100**
Sodium	**150**	**200**	**50**
Potassium	**100**	**500**	**<1000**

Limitations by tartrate salts crystallisation & precipitation

Limited direct perception of Sodium, Potassium and Calcium in wine!
(but potential indirect impact…)

Hodson et Linden; Physiology & Behavior 2006
Feron, J Texture Stud. 2019
Carpenter, 2013 Ann Rev Food
Canon et al., 2018 J. Agric. Food Chem.