Orosensory detection of dietary lipids : *Do we taste fat ?*

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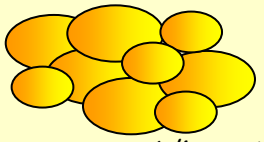
AgroSup Dijon, UMR INSERM U866

Why is fat so attractive ?

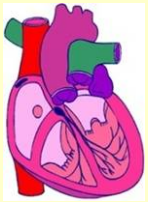
LIPIDS

Is there a taste for fat ?

Health impact



Adipose tissue



Heart

Obesity, atherosclerosis, type 2 diabetes, hypertension...

An innate preference for fatty foods

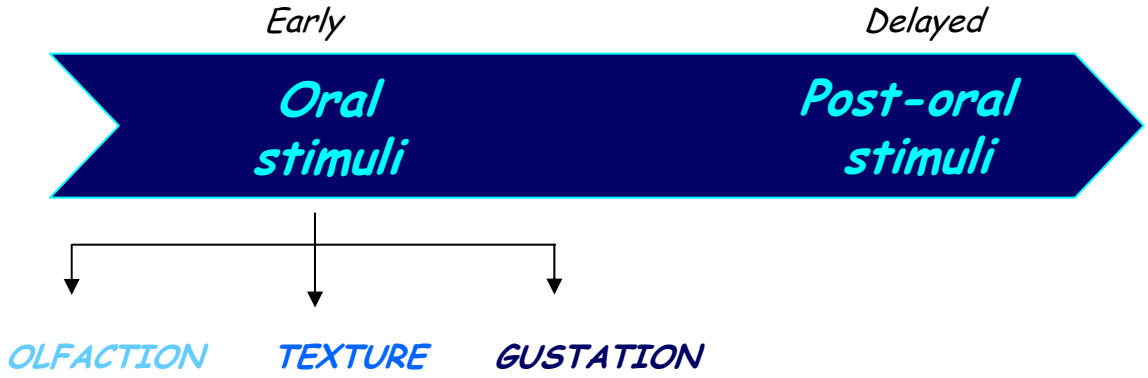
Rats and mice spontanously prefer high fat diets

Hamilton, J. comp. Physiol. Psychol. 1964, 58: 459-60; Tsuruta et al., Physiol. Behav. 1999, 66: 285-88

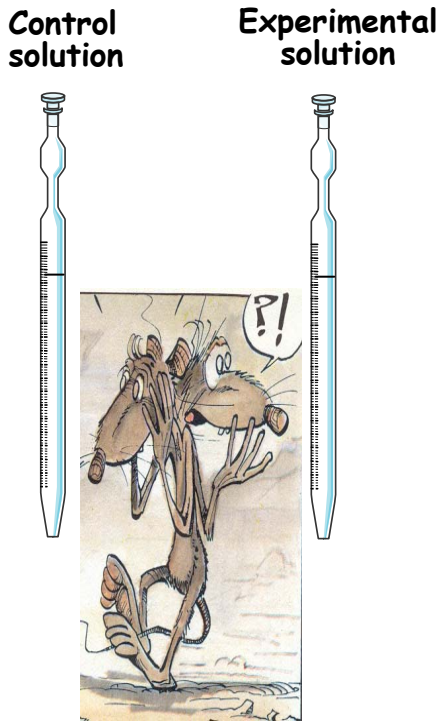
Neonates feed more actively on high fat milk

Nysenbaum & Smart Early Hum. Dev., 1982, 6: 205-13

How is fat detected ?

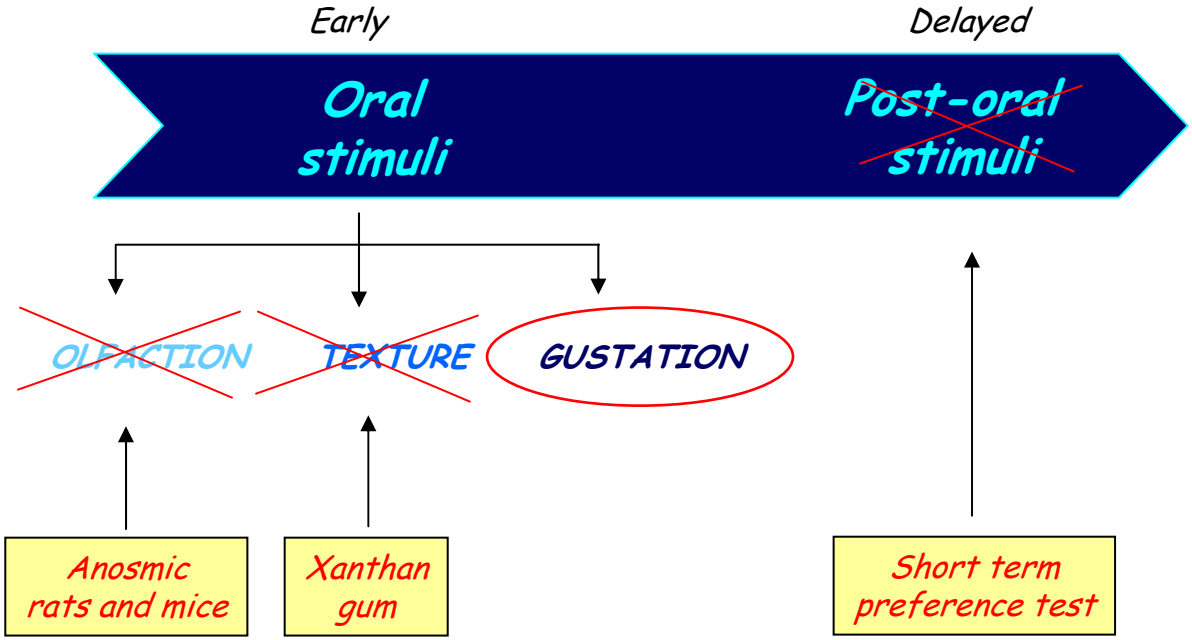


Two bottle preference test

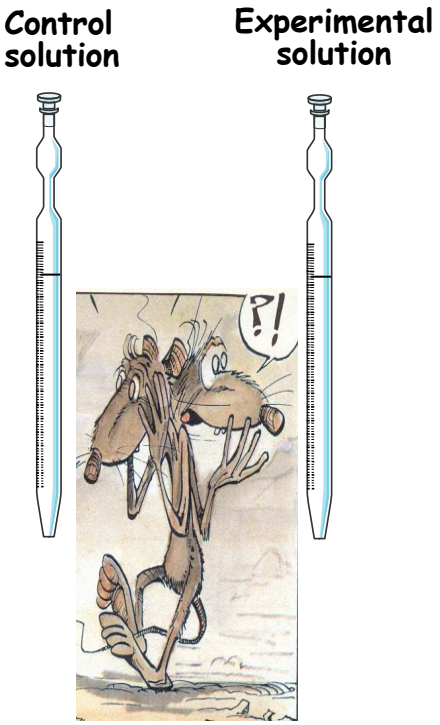


Taketa et al., Life Sci. 2000, 69, 847-54
Fukuwatari et al. Physiol. Behav. 2003, 78, 579-83

How is fat detected ?

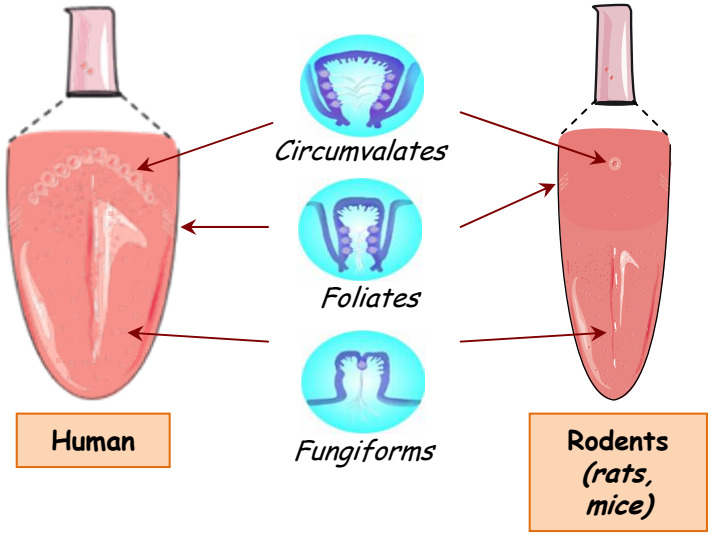


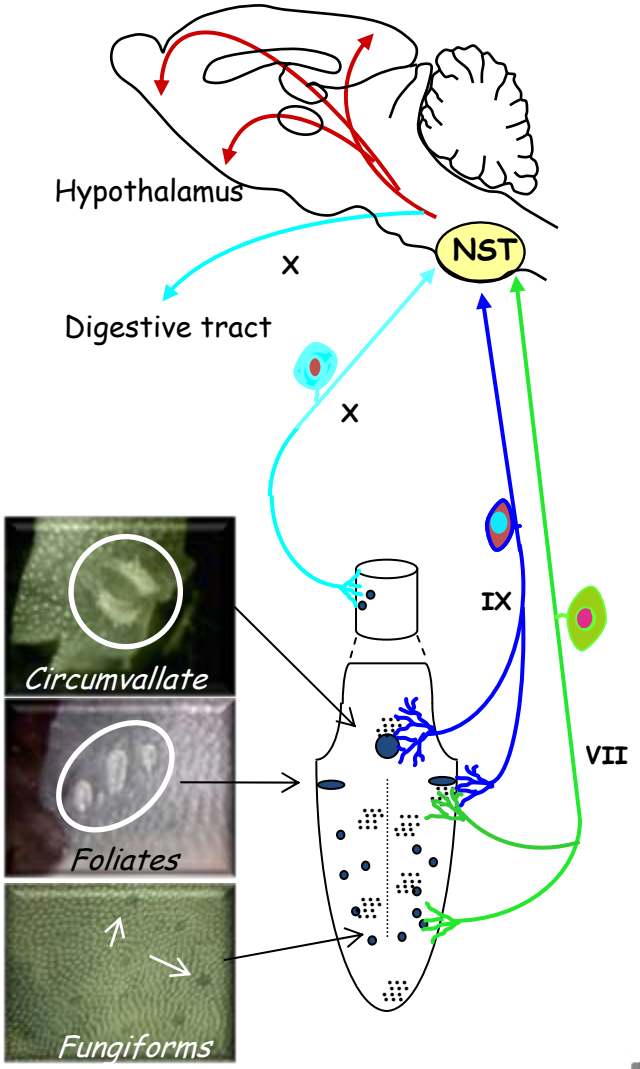
Two bottle preference test

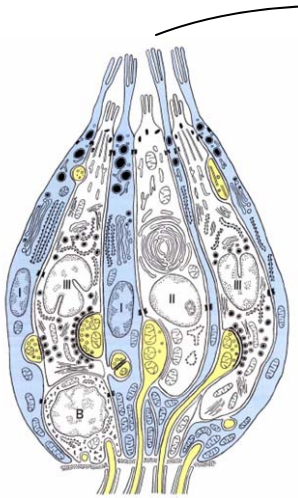


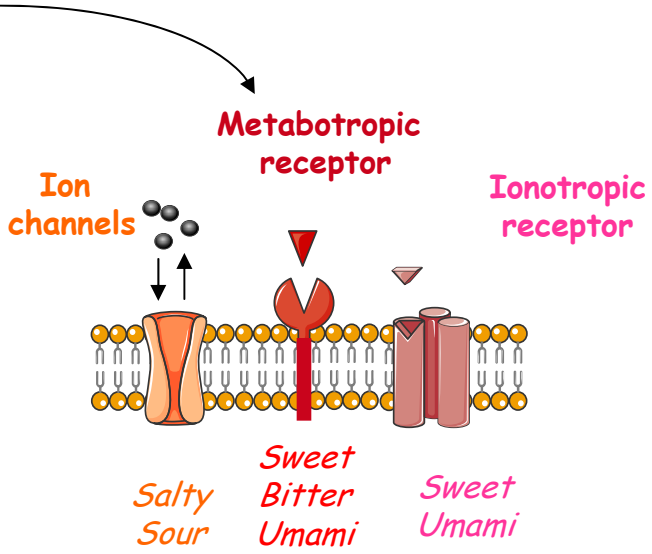
Taketa et al., Life Sci. 2000, 69, 847-54
Fukuwatari et al. Physiol. Behav. 2003, 78, 579-83

Anatomy of oral taste system









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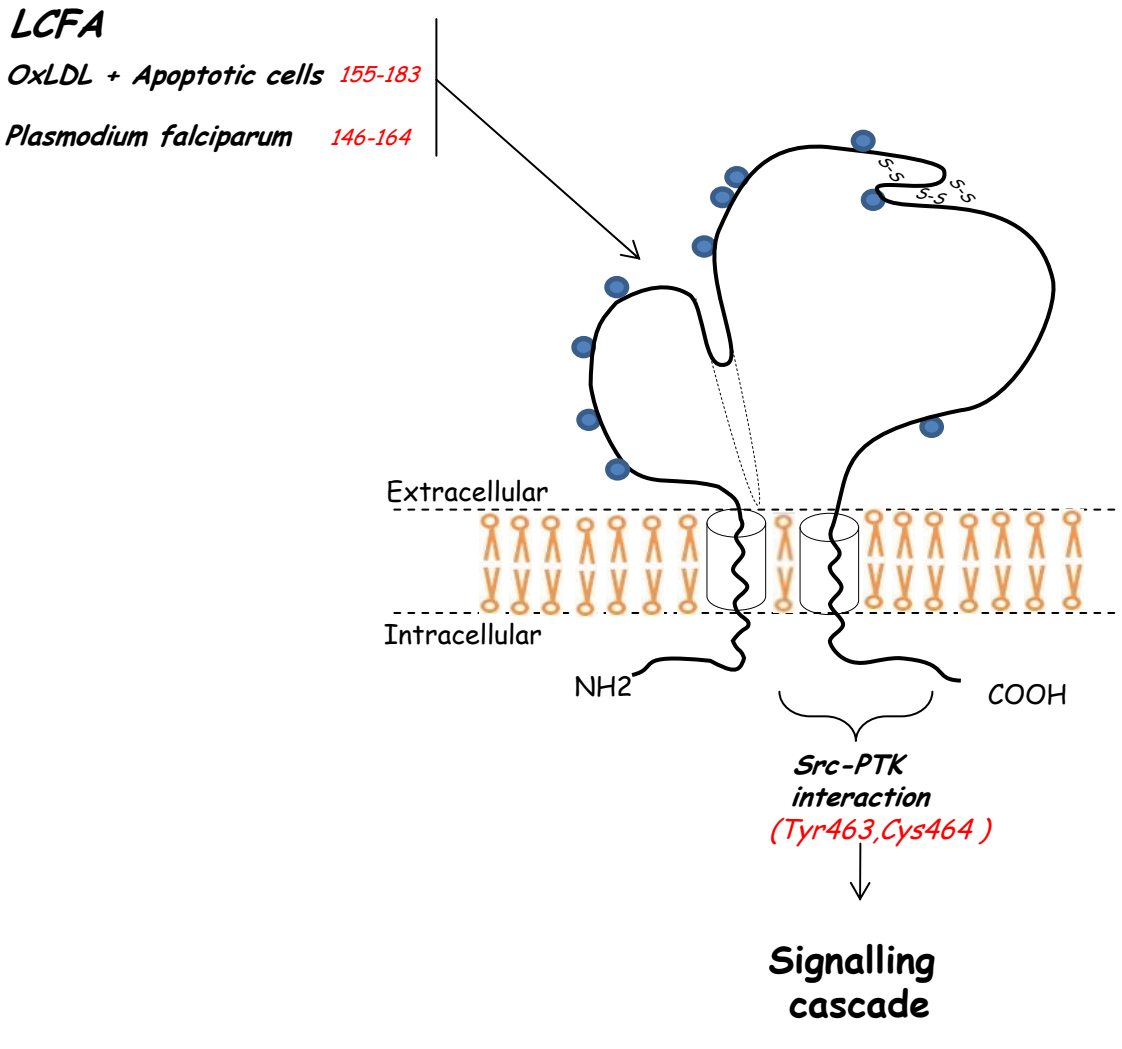
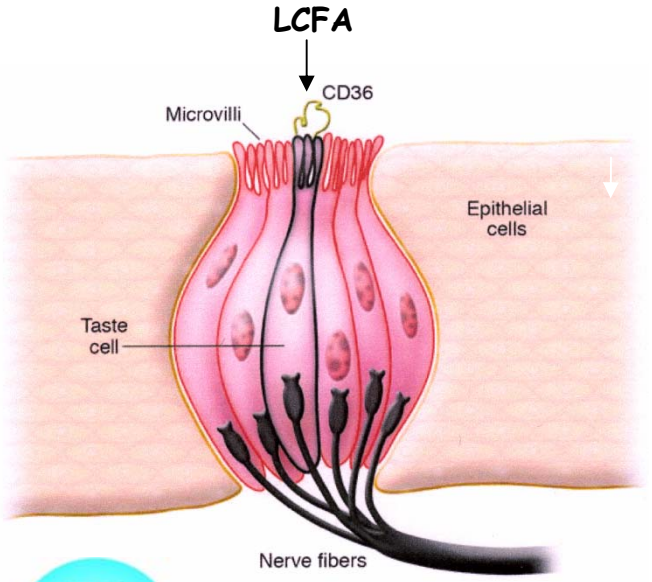
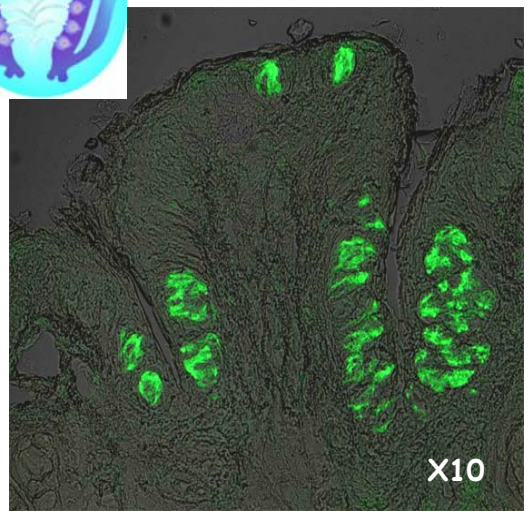
CD36

- Multifunctional protein which belongs to the scavenger receptor family as SR-B1
- Receptor-like structure



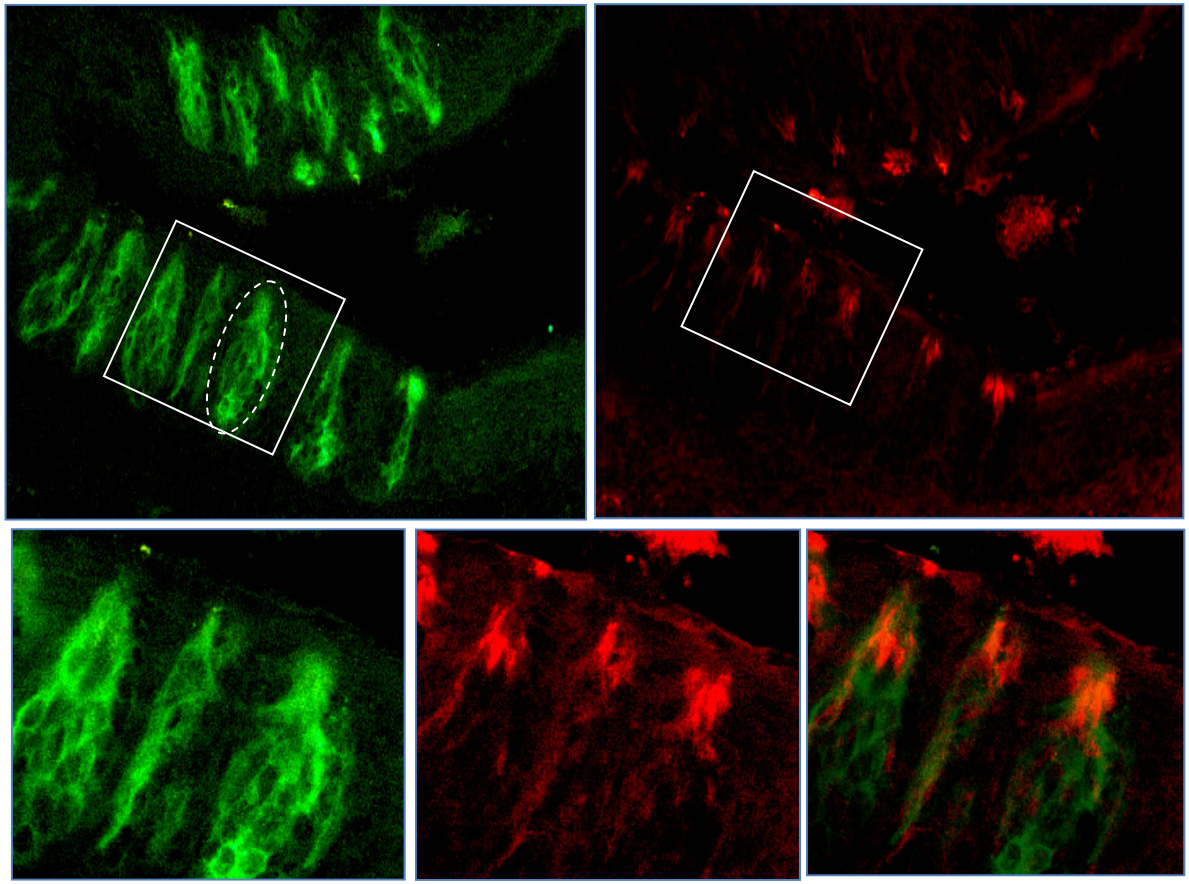
CD36 is located in the apical side of taste receptor cells of lingual papillae





α-gustducin

CD36



Laugerette et al., J. Clin. Invest. 2005, 115: 3277-84

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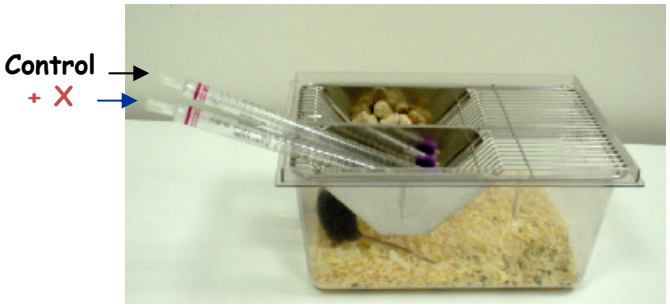
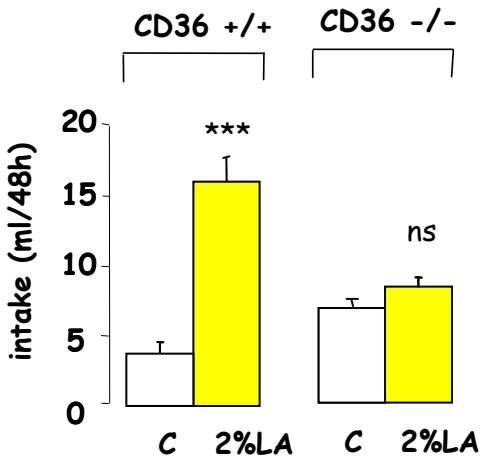
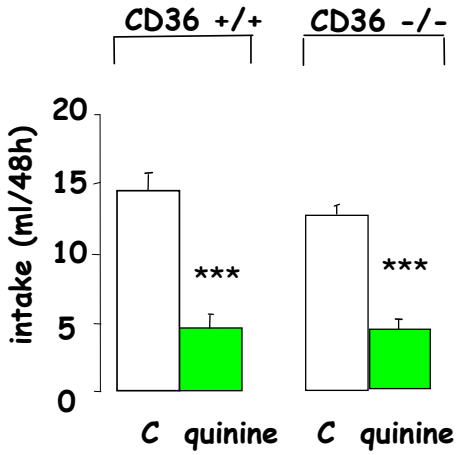
CD36
null mice

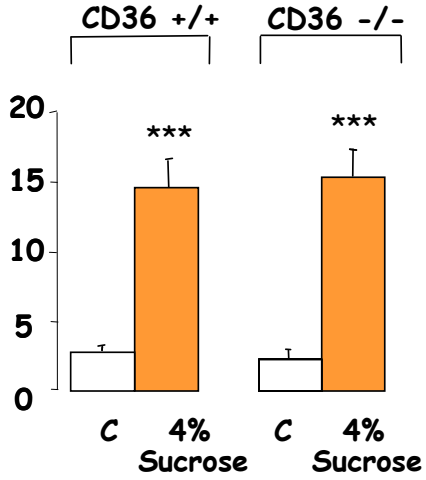
CD36 is involved in long-term preference for fat

Two bottle preference test









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Laugerette et al., J. Clin. Invest. 115: 3277-3184, 2005

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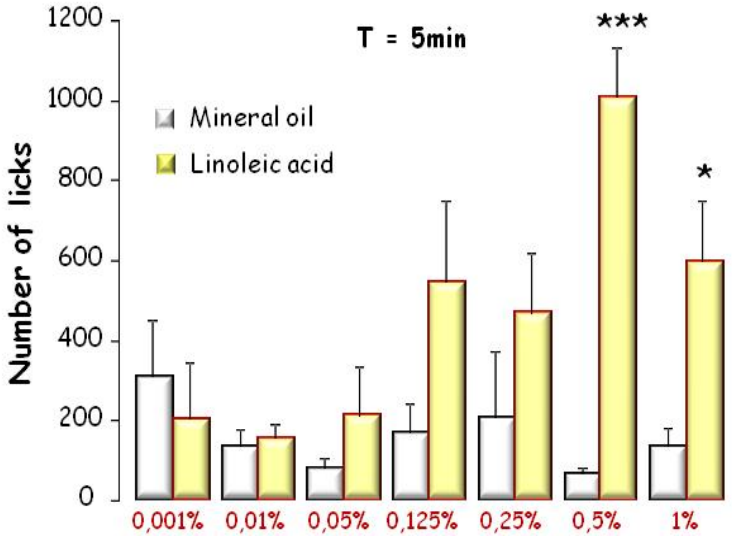
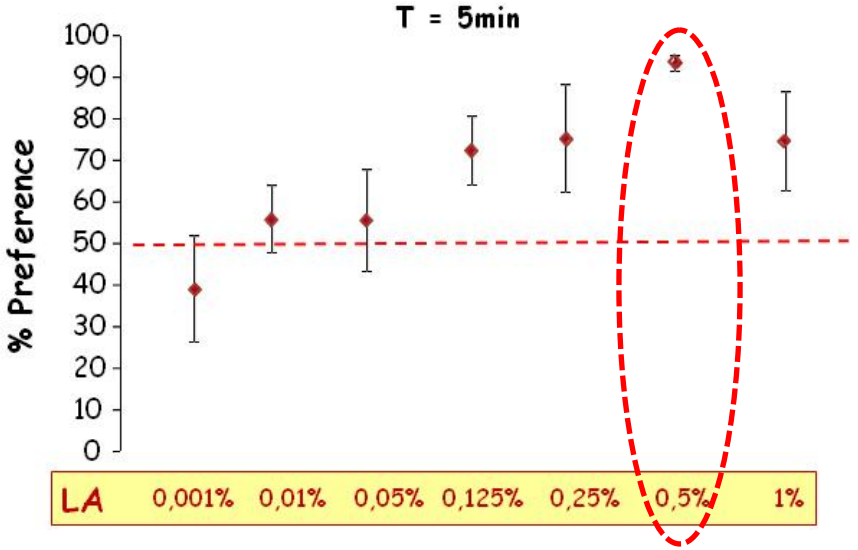
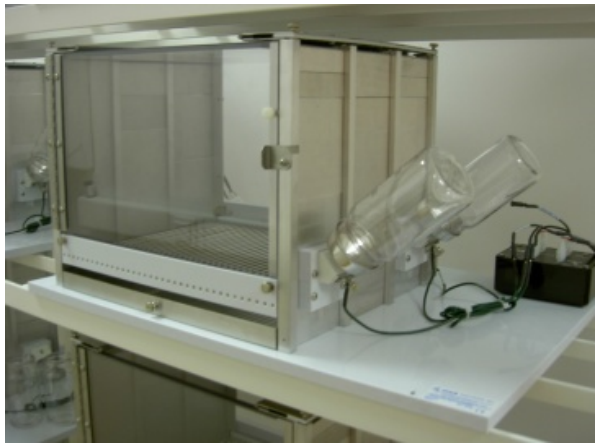
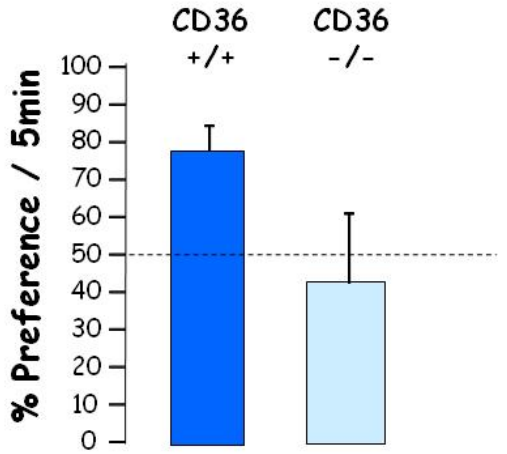
CD36 is involved in short-term preference for fat







Lickometer



Martin et al., submitted

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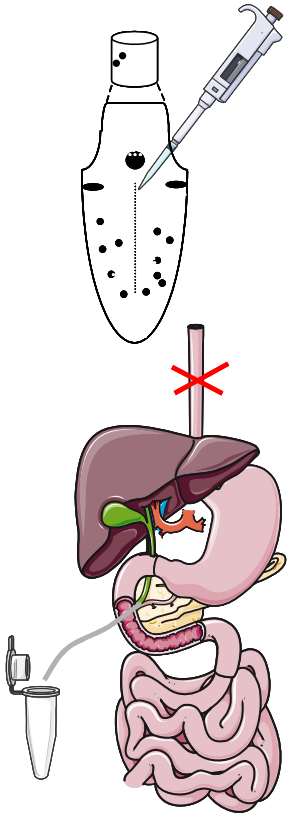
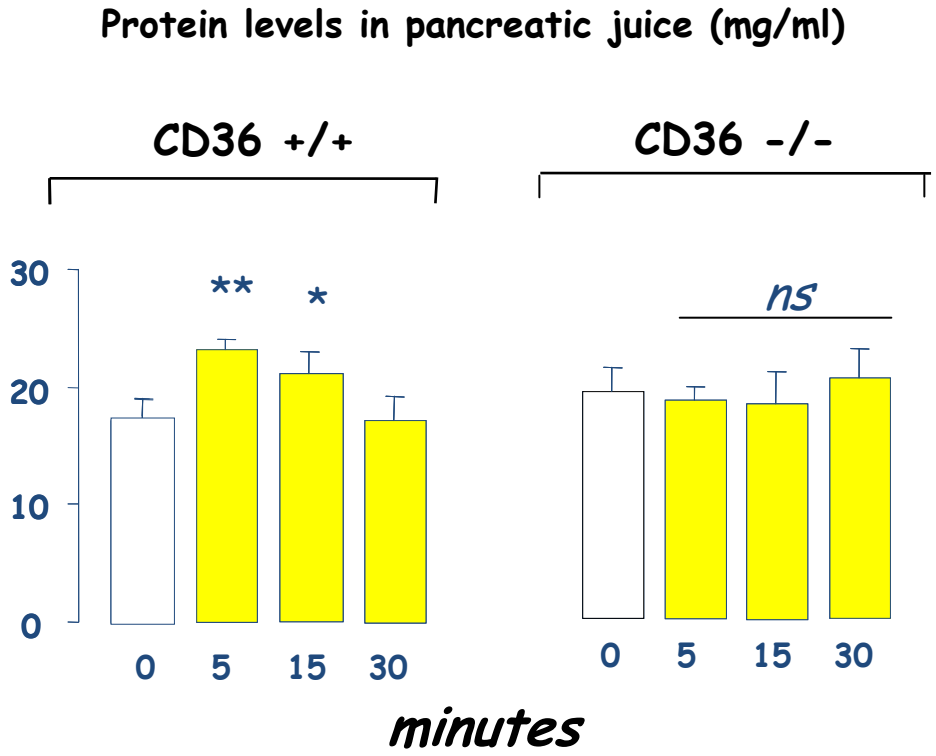
CD36
null mice

Lingual CD36 participates to the cephalic phase of the digestion.

Oral lipid load is sufficient to enhance the protein content of pancreatobiliary juice in rats.

Hiraoka et al. 2003, Physiol. Behav. 79: 713-717

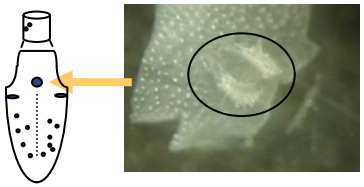




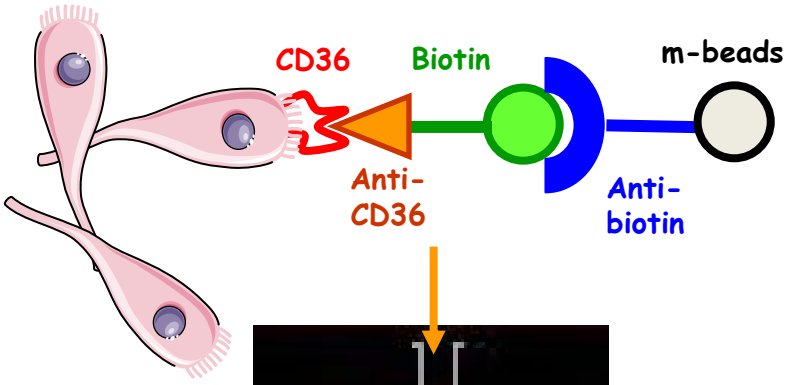
Laugerette et al., J. Clin. Invest. 2005, 115: 3277-84

Isolation of CD36-positive taste bud cells

Isolation of CV papillae

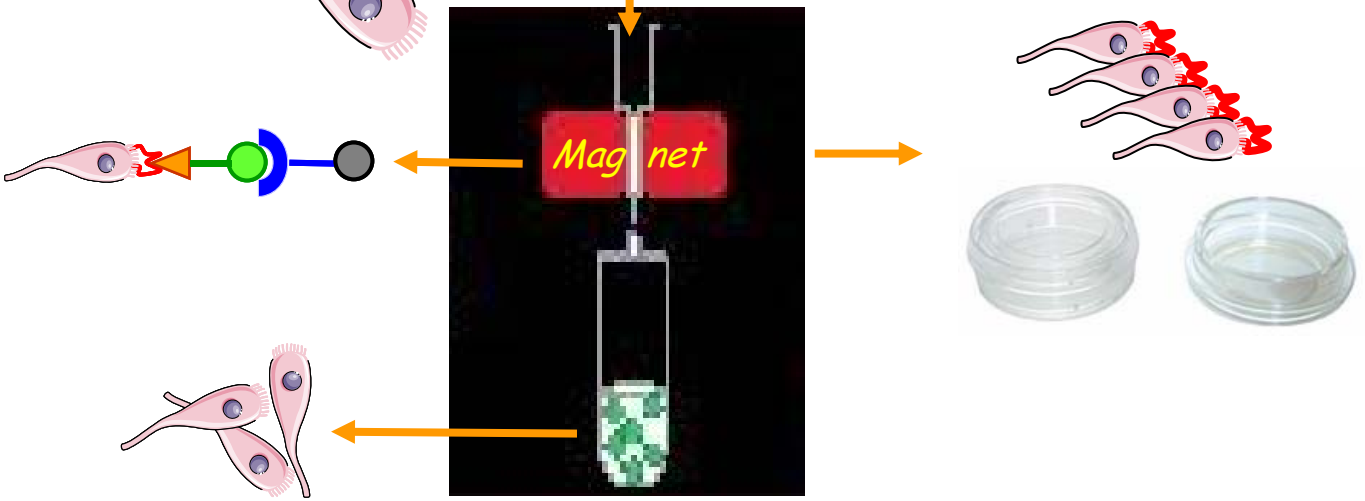


Heterogenous cellular population



CD36-positive cells

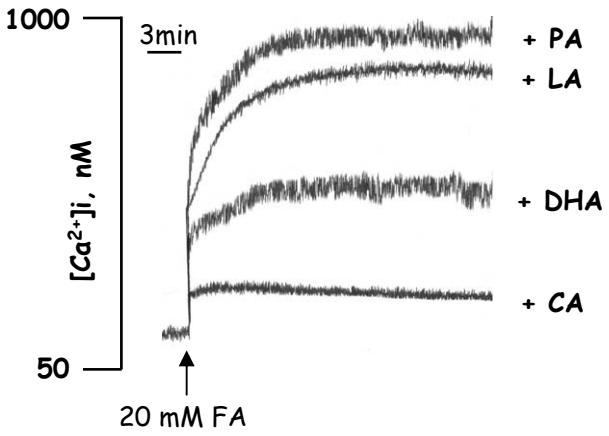
CD36-negative cells

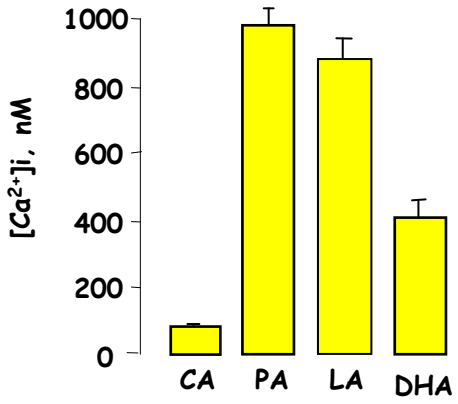


"MACS Column"
Miltenyi magnet system

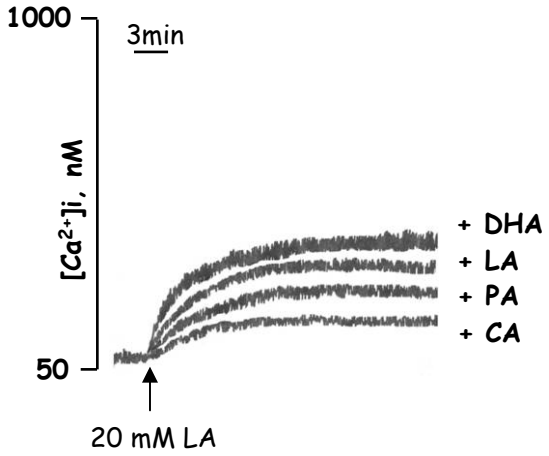
LCFA induce a rise in [Ca 2+]i in CD36+ TRC

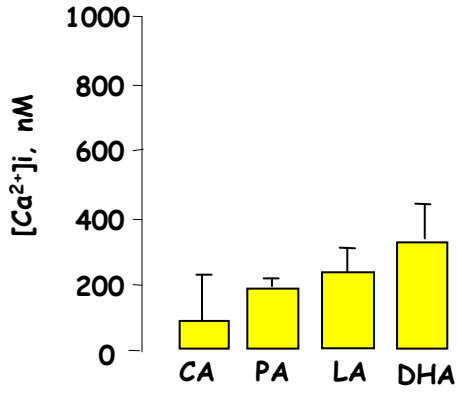
CD36-positive TRC



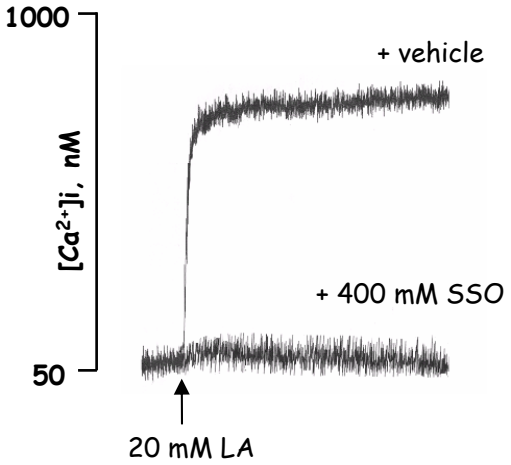


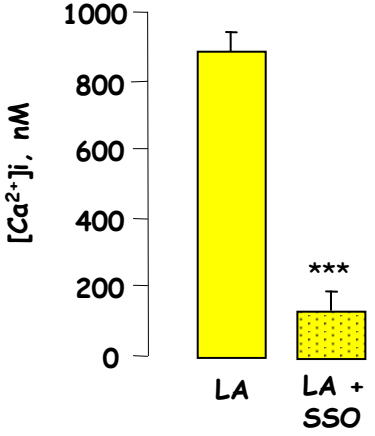
CD36-negative TRC





CD36-positive TRC





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Gaillard et al., FASEB J. 2008, 22: 1458-68

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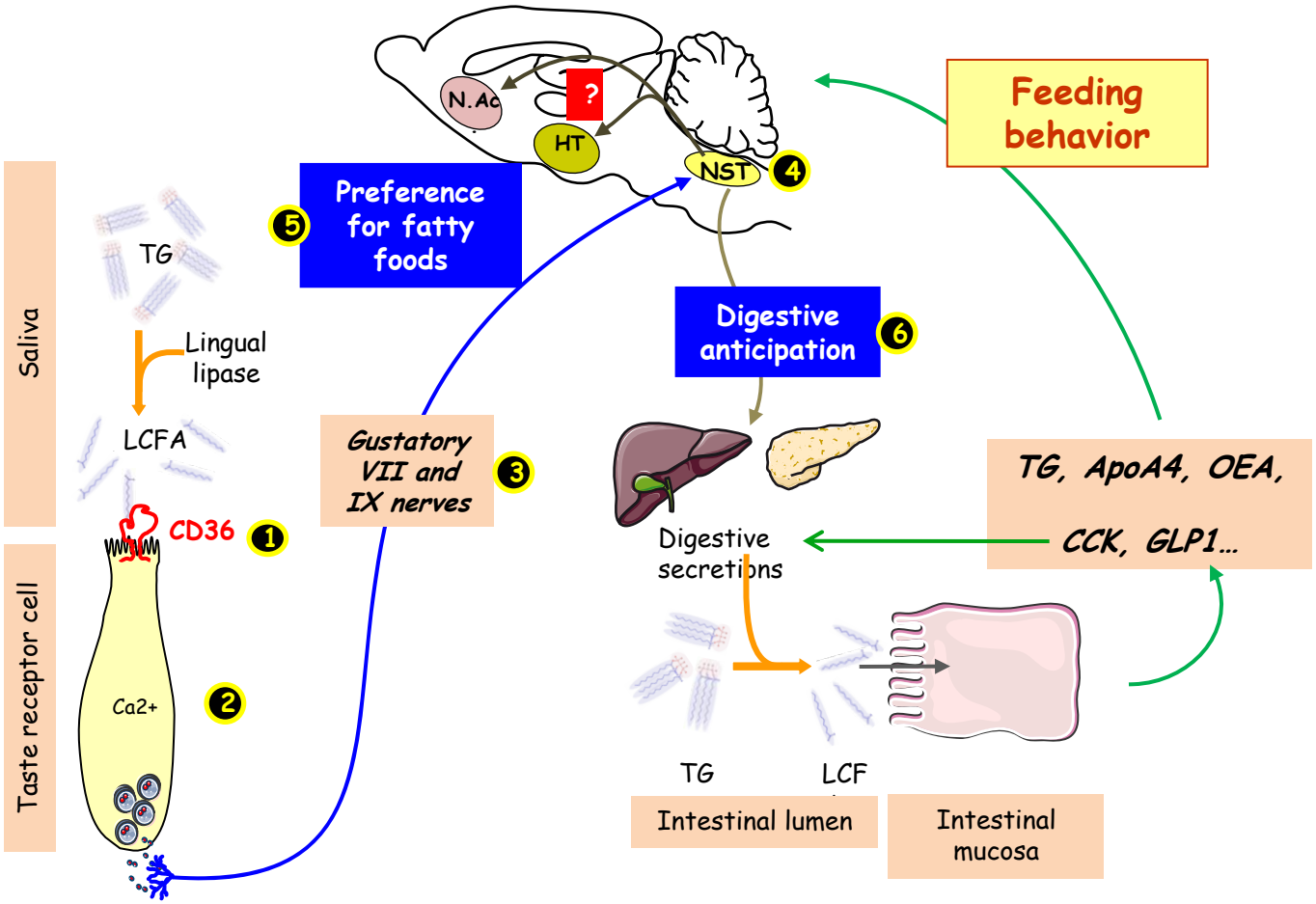
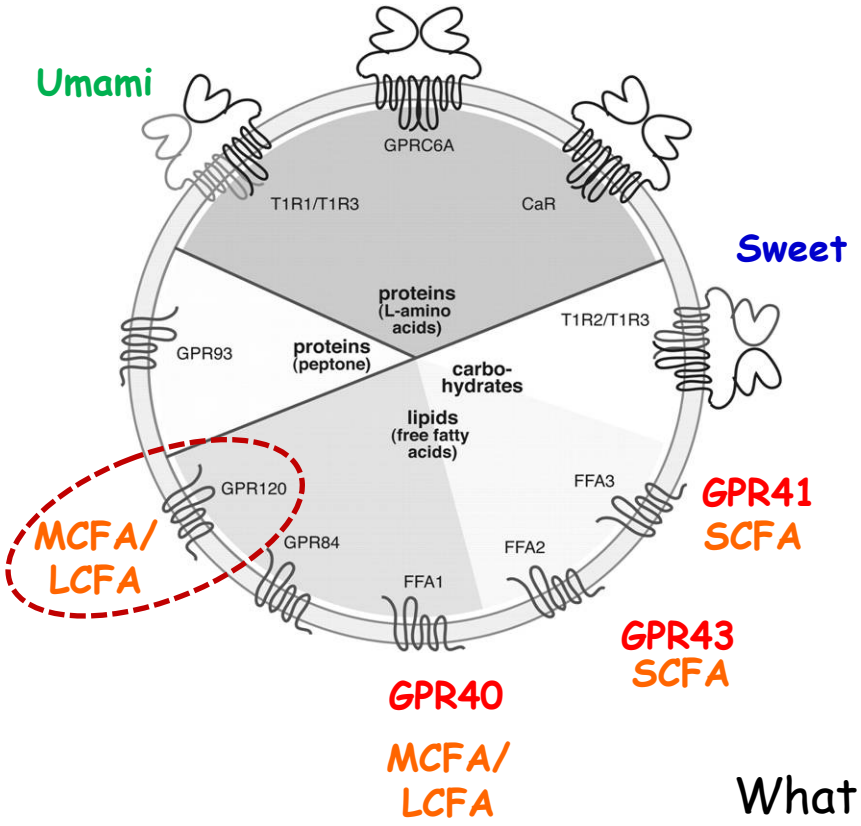
Contribution to a new concept :

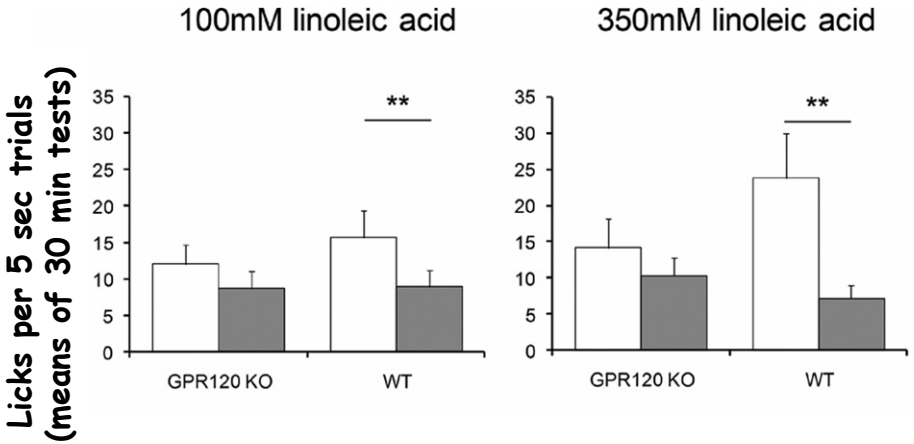
Lingual CD36 is likely a gustatory lipid sensor which participates to the oro-sensory detection of dietary lipids and cephalic phase of digestion in the mouse.



Laugerette et al. 2005 J Clin Invest. 115: 3177-84
Gaillard et al. 2008 FASEB J. 22: 1458-68
El yassimi et al. J. Biol. Chem. 2008, 283: 12949-59

Taste preference for fatty acids is (also) mediated by members of GPCR family





Cartoni et al. J. NeuroSci. 2010, 30 : 8376-82

What is (are) the respective role(s) of CD36 and GPR120 in the taste bud cells ?

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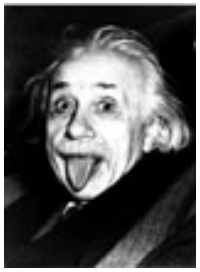
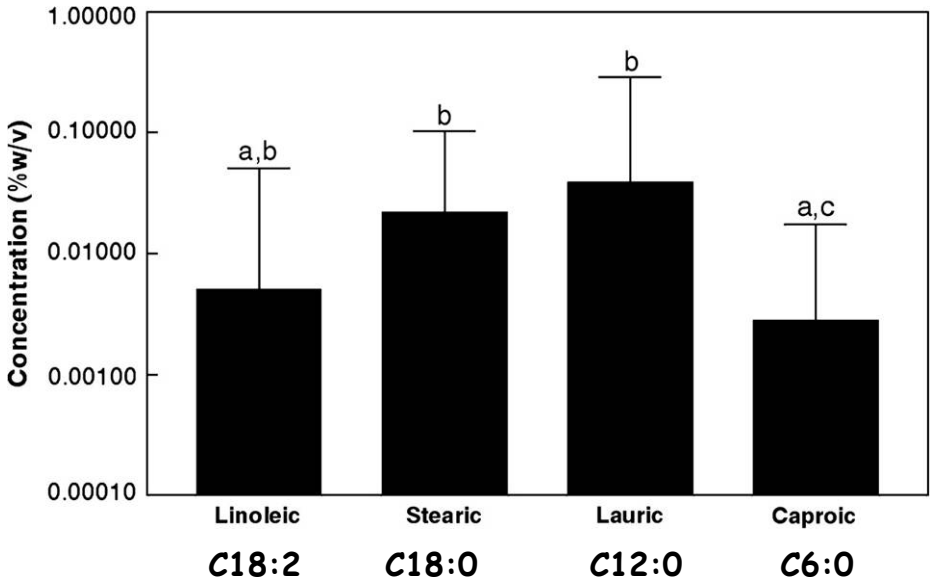
Orosensory perception of dietary lipids in Human



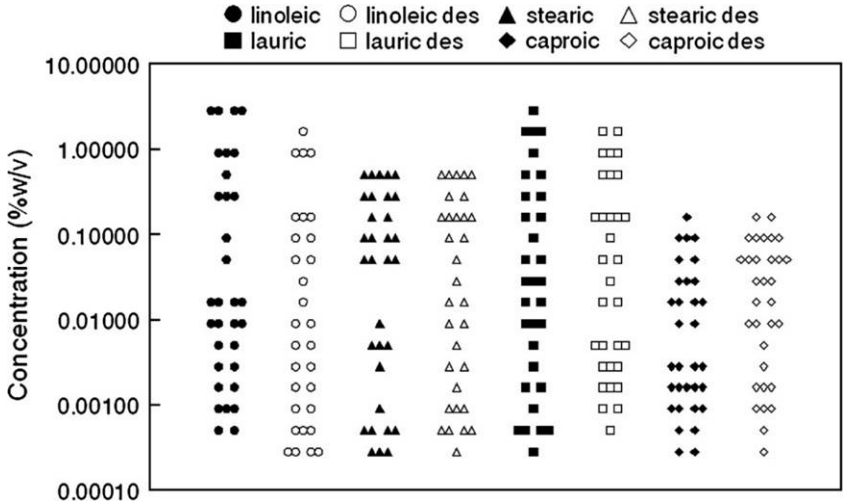
Chemosensivity to FFA in humans

32 healthy adults
Nares closed
Tongue desensitized to irritation (capsaicin)
Red light
5% gum acacia (viscosity)
5% mineral oil (lubricity)

Median fatty acid detection thresholds (N = 32)



Distributions of fatty acid detection threshold values (N = 32).



Obese patients exhibit a higher preference for fat than lean subjects.

Drewnowski et al., Physiol. Behav. 1985, 35: 617-622
Mela & sacchetti, Am. J. Clin. Nutr. 1991, 53: 908-915

Sensory and hedonic properties of sweet and fat vary with body mass index.

Barthoshuk et al. Philo Trans R SocLond 2006, 361: 1137-48

British Journal of Nutrition (2010), page 1 of 8

doi:10.1017/S0007114510000267

Oral sensitivity to fatty acids, food consumption and BMI in human subjects

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(Received 16 September 2009 – Revised 13 January 2010 – Accepted 14 January 2010)

FA Sensitivity ↑ = Fat Intake ↓ = BMI ↓

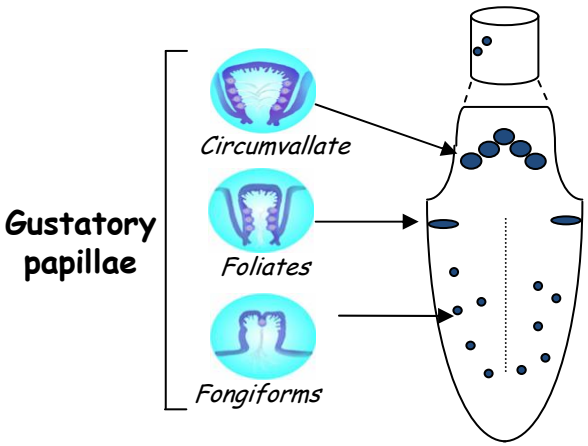
GENERAL CONCLUSIONS 1

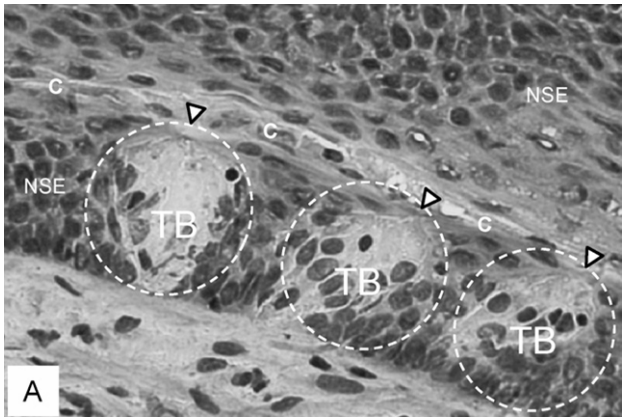
Lingual CD36 appears to be a gustatory lipid-sensor involved in both the selection and digestion of lipid-rich foods in the mouse.

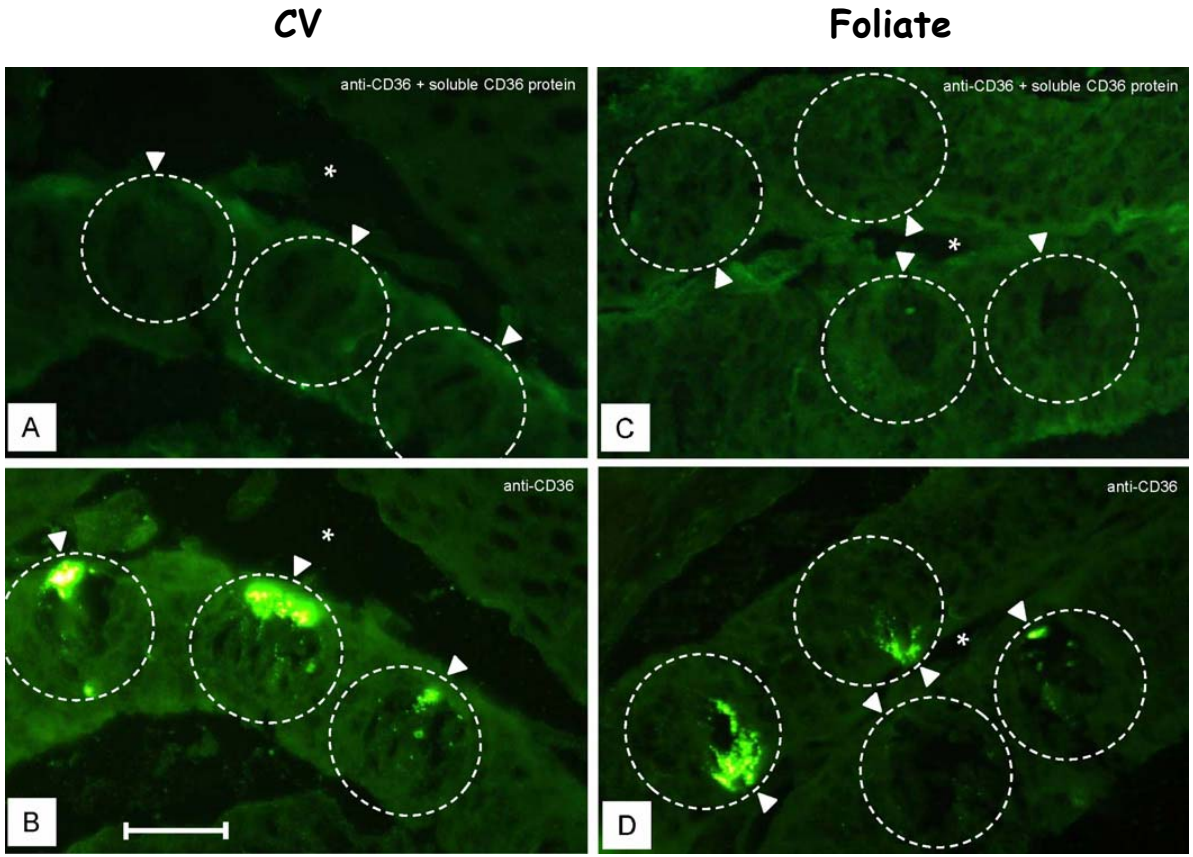
Sense of taste seems also to be involved in the detection of dietary lipids (free fatty acids) in healthy humans.

If CD36 or other lingual lipid sensors are involved in this lipid perception system is unknown in Human.

Apical CD36 immunolocalization in human taste buds from circumvallate and foliate papillae







Simons et al. Acta Histochem 2010, in press

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GENERAL CONCLUSIONS 2

Orosensory (taste) perception of dietary fats might facilitate the body storage of lipids during periods of nutritional abundance. This event likely constitutes an advantage to survive when food is scarce.

Conversely, it might contribute, with other orosensory and post-ingestive parameters, to obesity in times of continuous food availability.

GENERAL CONCLUSIONS 3

Besides the fundamental interest of this issue (is there a sixth taste modality?), many questions are still raised :

What are the respective functions of CD36 and GPR120 in the tongue?

Are there other lingual lipid-sensors sensitive to medium-chain fatty acids and short chain?

Disturbance of the oro-sensory detection of dietary lipids may contribute to the development of obesity and/or linked pathologies ?

If so, the development of agonists or antagonists of specific lipid-lingual receptors could be interesting.
Work in this direction are currently underway.

Contributors

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