The Sense of Taste

Function of Gustation

- Designed to detect picomolar (10-12) concentrations of bitter substances
- Detects molar concentrations of nutritious substances
- Humans perceive sweet, sour, bitter, salty and umami
- Olfaction and taste collaborate in determining flavor.
- The somatosensory system establishes both localization and texture.
Organization of taste buds on the tongue

Taste buds contain 50-100 taste cells

Taste cells are not neurons
Short lifetimes

Similar molecules – different taste

Saccharin
Sweet

Aspartame
Sweet
Bitter
Tasteless
Very different molecules are bitter

<table>
<thead>
<tr>
<th></th>
<th>Cucurbitacin B</th>
<th>Amarogentin</th>
<th>Strychnine</th>
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<tbody>
<tr>
<td>Bitter thresholds</td>
<td>1.8 nM</td>
<td>0.6 µM</td>
<td>2 µM</td>
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Models of Taste Coding

Model A: Across-fiber patterning
Taste cells recognize multiple modalities; brain must compare different cells activity to know what the mouth tastes.

Model B: Labeled lines
Taste cells recognize one modality; sweet cells fire and the brain perceives sweet.

Different taste receptors recognize different tastes

- T1R1 + T1R3 = amino acid
- T2Rs = bitter
- T1R2 + T1R3 = sweet
Sweet taste

Mutant mouse cannot detect saccharin
Mutation is in a G protein coupled receptor
Two other receptors are nearby
T1R gene family = 3 genes

T1R taste receptors localize to the taste pore

Basic Techniques in Neurobiology
Identifying ligands for receptors by calcium imaging

1. Put receptor gene + G15 into cells

2. When receptor is activated by ligand, Activates G15 leading to Ca increase
   PLC—IP3 + DAG— Ca release

3. Calcium dye changes fluorescence
T1R2 and T1R3 together recognize sugars

+ T1R2  + T1R3  + T1R2 + T1R3

T1Rs are selectively co-expressed in taste cells

T1R1+3 & T1R3  T1R2+3

Mice lacking T1R2 or T1R3 do not detect sugars

Expt: Give mice choice between water or water plus sugar
Different taste receptors recognize different tastes

- T1R1 + T1R3 = amino acid
- T2Rs = bitter
- T1R2 + T1R3 = sweet
The T2Rs are a family of novel taste GPCRs found nearby genomic regions associated with bitter taste variations.

Most T2Rs are co-expressed in the same cells.

T2Rs function as receptors for bitter tastants.
There is no significant overlap between cells expressing sweet, bitter and amino acid receptors

Cross sections of a tongue labeled with receptor-specific antibodies

Taste cell activation generates taste behaviors

Expt: Put human bitter receptor into mouse taste neurons

Result: Mice like the compound if the receptor is in T1R cells
They avoid the compound if the receptor is in T2R cells

Expression of T1Rs and T2Rs suggests that there are bitter cells and sweet cells

Supports labeled line model of taste coding
Many taste signaling cascades have been proposed

T1Rs and T2Rs use a PLC-mediated cascade

Are T1Rs and T2Rs in different cells?

Expt 1: knockout PLC— mice can’t detect sweet or bitter

Expt 2: put PLC back in under control of one T2R promoter

what happens?
Taste cells innervated by 3 nerves
facial (VII)
glossopharyngeal (IX)
vagus (X)

Solitary tract nucleus of medulla

hypothalamus, amygdala, gustatory cortex

Taste Recognition in *Drosophila*

Dept. of Molecular and Cell Biology
University of California, Berkeley

Taste organs in *Drosophila*
Main points about taste

- T1Rs recognize sugars
- T2Rs recognize bitter substances
- We recognize different modalities because we have sugar cells, bitter cells, etc..
- Labeled line taste coding