Gustation: Detect chemicals that become dissolved in our saliva using the gustatory system:
- Produces perceptual quality of taste

Olfaction: Detect airborne chemicals through our olfactory system:
- Produces perceptual quality of smell

Evolution of Chemosensory Perception
- Marine organisms follow water-borne nutrition gradients.
  With terrestrial life forms and air as the medium, Olfaction served as a primitive ‘tele’ (distant) detection system for chemical stimuli, whereas Gustation became specialized for near detection (and the ‘gateway’ to the alimentary canal...)
- Chemical communication:
  - Ability to mark territory boundaries, interact with other species, signal sexual receptiveness, etc.

Human Chemosensory Perception
- Why are humans sensitive to chemicals?
  - Chemical signals are very important for many mammalian species, but humans rely much more on vision and hearing.
  - However, chemical senses are still consequential to humans:
    - Infants detecting the odours from their mothers’ breasts
    - Menstrual synchrony (adaptive mechanisms?)
    - Taste providing survival value for detecting poisonous foods and also enhances eating experience through by making selectivity possible

Human Chemosensory Perception
- How does human chemosensory function differ from other animals?
  - Pheromones play an important role in nonhuman animals.
  - Vomeronasal organ (VNO) is a separate chemosensory organ that detects pheromones:
    - Existence of VNO is well established in terrestrial mammals, but controversial whether humans also have one that is functional.
  - Most mammalian species are far more sensitive to a broad variety of odours than humans are.
Characteristics of Chemosensory Perception

- Chemosensory systems can affect our emotions:
  - Olfactory system has direct contact with the limbic system in the brain.
  - Implications for evolution...

The Gustatory System

'primary' gustatory sensations (salty, sour, bitter, sweet and umami)
'ancillary' gustatory sensations (astringent, pungent, meaty...)

Taste buds, which contain the taste receptors, are found on the tongue, as well as in the oral cavity (mainly on the roof and back of the mouth).

Taste receptors in the tongue:
- Taste receptor cells are located inside the taste bud
- Each taste bud contains 50–150 receptor cells.
- Dissolved chemicals, called tastants, produce a change in the membrane potential that leads to neurotransmitter release.
- Gustatory signals from taste buds in the front two-thirds of the tongue are transmitted through the facial nerve (CN VII), whereas signals from the back one-third are carried by fibres that belong to the glossopharyngeal nerve (CN IX).
- Vagus nerve (CN X) carries gustatory signals that arise from taste buds at the back of the throat.

The Gustatory receptors in the oral cavity (tongue & mouth)

Embryogenesis: Ectodermal germ layer: anterior 2/3 of tongue; Endodermal germ layer: posterior 1/3 of tongue

“Primary” taste qualities each have their own transduction mechanism

Ionic channel transduction: salty and sour tastes

Receptor-mediated transduction: sweet, bitter and umami tastes
Signal transduction mechanisms:
- Ionic channel mechanisms code for salty and sour tastes:
  - Ingestion of salt leads to entry of Na⁺ into the taste receptor cell through a sodium channel in the membrane, causing a membrane depolarization that travels to the opposite end of the cell where it releases a neurotransmitter substance.
  - Sour tastes contain acid, which are high in Hydrogen ions – these also enter through sodium channels, which depolarizes the receptor cell.

Coding of taste signals:
- 'labeled-line' versus ‘cross-fibre’ coding:
  - Labeled-line system:
    - Each nerve fibre is responsible for transmitting information that is highly specific and restricted to a particular sensory modality.
    - But with taste, individual receptor cells can respond to several taste stimuli, and a single nerve fibre can receive signals from more than one taste bud, and each taste bud can send its signals through more than one gustatory fibre.
  - Cross-fibre coding:
    - Different taste qualities are distinguished by the pattern of discharges across a large population of fibres

Coding of taste quality and intensity:
- Many gustatory fibres show a preference for a particular taste primary even though they may be stimulated by several different tastes.
- Taste quality is best represented by the cross-fibre pattern of firing.
- Intensity is encoded by the firing rate of action potentials in gustatory fibres:
  - Increase firing with increasing taste concentrations.

Coding of taste signals:
- Regional differences in taste across the tongue:
  - All four taste qualities are processed by taste buds located throughout the tongue.
  - But there are some regional preferences for certain taste qualities, producing an uneven distribution across the tongue (called chemotopic organization):
    - More sensitive to sweet and salty at the tip of the tongue
    - More sensitive to bitter and sour at the back of the tongue
Gustatory processing in the brain:
- Subcortical relay sites for gustatory signals
  - Nucleus of the solitary tract (NST) = the first subcortical structure, located in the brainstem, that serves as a relay station for gustatory signals
  - Ventral posterior medial nucleus (VPMN) = second subcortical relay station located further up the taste pathway within the thalamus

Primary gustatory cortex:
- Projections from thalamus arrive into an area of the frontal lobe known as the insula.
- Neurons in the primary gustatory area are responsive to all primary tastes, but most neurons have a preference for a particular taste.

Secondary gustatory cortex and beyond:
- Orbitofrontal cortex = secondary gustatory cortex that processes higher aspects of taste function
  - Enhanced taste sensation under conditions of hunger
  - Gateway by which taste signals reach other areas of the brain, such as the hypothalamus and amygdala
  - May combine various sensory modalities involved in food (sight, texture, smell, and taste)

Psychophysical techniques for taste measurement:
- Multiple problems with all techniques:
  - There is a lack of agreement on the nature of taste qualities.
  - Different methods can yield different results.
  - Stimuli are difficult to effectively control.

Psychophysical techniques for taste measurement:
- Electrogustometry:
  - Delivers a small electric current through an electrode to a specific region of the tongue
- Regional chemogustometry:
  - Application of a chemical solution to a restricted part of the tongue
- Whole-mouth chemogustometry:
  - Uses the entire taste apparatus to make an assessment of gustatory function
- Assessment of taste abnormalities:
  - Ageusia = total loss of taste
  - Hypogeusia = reduction in taste sensitivity
  - Dysgeusia = taste distortions occur

Functional properties of taste neurons in gustatory cortex
The “receptive fields” of single units in gustatory cortex show preference for tastants that give rise to sweet and salty taste sensations... Why?
Perception of intensity:

- Detection thresholds:
  - Generally, bitter substances have the lowest detection thresholds, followed by sour, salt, and sweet.
  - Taste thresholds appear to be additive:
    - Gustatory system integrates taste signals across the various primary tastes.
  - Relationship between threshold and temperature is a U-shaped function for all the taste primaries.
  - Detection thresholds increase with age for each taste primary.

Gustatory detection thresholds for some common tastants.

Expressed in concentration values (millimoles per litre) of the dissolved substance in water.

<table>
<thead>
<tr>
<th>Taste</th>
<th>Threshold (mmol/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sweet</td>
<td>Sodium: 0.000, Aspartame: 0.007</td>
</tr>
<tr>
<td></td>
<td>Sucrose (table sugar): 0.65</td>
</tr>
<tr>
<td>Salty</td>
<td>Calcium chloride: 0.060, Sodium chloride: 1.0</td>
</tr>
<tr>
<td></td>
<td>Potassium chloride: 6.5</td>
</tr>
<tr>
<td>Sour</td>
<td>Citric acid: 0.07, Acetic acid: 0.1</td>
</tr>
<tr>
<td>Bitter</td>
<td>Quinine: 0.001, Capsaicin: 0.06, Lime: 15.0</td>
</tr>
<tr>
<td>Uranus</td>
<td>Monkoneum glutamate: 0.05</td>
</tr>
</tbody>
</table>

Perception of intensity:

- Suprathreshold intensity perception:
  - Taste appears to be the least sensitive of our sensory functions in terms of discriminability.

Temporal and spatial factors:

- Detection thresholds are susceptible to various temporal conditions:
  - e.g., how rapidly the tastant is presented on the tongue, what was presented before, how long the taste may linger after being detected
- Extent of spatial stimulation can affect taste intensity perception:
  - Generally, the greater the area of stimulation, the lower the threshold.
  - Detection thresholds for each primary taste varies as a function of the part of the tongue that receives stimulation.

Adaptation:

- Occurs when the perceived intensity or sensitivity to a tastant decreases when that taste is applied continuously over the tongue.

Cross-adaptation:

- Occurs when the perceived intensity of a compound is decreased due to adaptation to a different one.

Genetic variations:

- PTC/PROP thresholds—non-tasters, tasters, and supertasters:
  - Non-tasters = 25% of people who have normal taste cannot detect the bitter taste of PTC/PROP
  - Supertasters = 25% of tasters are hypersensitive to PTC/PROP and may experience an overall higher level of tasting ability than others.

Miraculin—a glycoprotein extracted from the fruit of *Synsepalum dulcificum*

Miraculin binds to the sweet receptors and alters their shape (?) so that H+ ions (acids) will drive them...

Miraculin itself is not sweet. However, after the taste buds are exposed to miraculin, ordinarily sour foods, such as citrus, are perceived as sweet. This effect lasts up to an hour.

Not approved by FDA (sugar lobby?)

Short-term specific adaptation of gustatory receptors: Miracle Fruit

Glutamic acid stimuliates specific receptors located in taste buds: the amino acid receptor T1R1/T1R3 or other glutamate receptors like the metabotropic receptors (mGluR4 and mGluR1) which induce the taste known as umami, one of the five basic tastes (the word umami is a loanword from Japanese; it is also referred to as "savory" or "meaty").

Glutamic acid is a natural constituent of many fermented or aged foods, such as soy sauce, fermented bean paste, and cheese, and is also a component of hydrolyzed protein such as yeast extract.

The sodium salt of glutamic acid, monosodium glutamate (MSG), is a widely used additive in the food industry.
Olfactory System: Biological Mechanisms

- Olfactory epithelium:
  - Located at the upper margins of the nasal cavity where odourants (airborne chemicals) trigger the neural signals
  - Two routes to get to epithelium:
    - Orthonasal route through nostrils
    - Retronasal route through back of throat

The Olfactory Receptors (the superior region of the nasal cavity)

Olfactory Receptors

- Olfactory sensitivity: related to the number of receptors (both area of olfactory epithelium and density within it differ across species)
  - Area of Olfactory epithelium in the German Shepard: ~ 1500 mm$^2$
  - In Human: 25 - 50 mm$^2$
  - The sense of smell is nonexistent in cetaceans, which compensate with a well-developed sense of taste.
  - In many species, olfaction is highly tuned to pheromones; a male silkworm moth, for example, can sense a single molecule of bombykol.

Ascending Pathways of the Olfactory System

Olfactory epithelium (specialized patch of skin):
Composed of several layers of cells
- Olfactory epithelium:
  - Cellular composition of the epithelium:
    - Once odourants pass through the mucus layer, they encounter the olfactory sensory neuron.
    - Sensory neurons are bipolar.
    - Axons from several neurons combine to form a small nerve bundle that projects to the olfactory bulb.
    - Terminal ends of the dendrites contain cilia, where the interaction between odourants and olfactory sensory neurons occurs.

- Olfactory epithelium:
  - Sensory transduction in the olfactory epithelium:
    - Odour molecules bind to specific receptors at the cilia.
    - Approximately 1000 different types of receptors exist, each being sensitive to a broad set of odourants with some affinity for specific chemical structures.
    - Each sensory neuron expresses only one type of receptor.
    - Binding of odourant molecule to the receptor triggers the G protein, which produces cAMP, which increases the entry of Na$^+$ ions into the neuron and produces membrane depolarization.
    - Signal then travels to olfactory bulb via olfactory nerve.

- Olfactory processing in the brain:
  - Signal processing in the olfactory bulb:
    - Olfactory bulbs are paired oval structures that reside below the frontal lobe.
    - All incoming axons converge on a small area called the glomerulus:
      - Each sensory neuron projects to only one glomerulus but each glomerulus can receive input from sensory neurons over widespread areas of the olfactory epithelium.

- Olfactory processing in the brain:
  - Signal processing in higher cortical areas:
    - M/T cells send axons to several brain areas
      - Piriform cortex is believed to process fundamental sensory aspects of olfaction.

- Olfactory processing in the brain:
  - Three different types of neurons in the glomerulus:
    - Mitral and tufted cells (M/T cells) both serve as relay neurons that send signals to higher brain centres.
    - Periglomerular cells serve as an interneuron that encircles the glomerulus.
    - It is thought that information about different odourants is mapped onto different glomeruli.
Coding of olfactory signals:
- Chemical coding of odourants:
  - Odotope = the set of features of an odourant molecule that are necessary to trigger a neural response
  - Standard features (molecular weight, polarity, solubility, and isomerism) are critical, but still no known relationship between structural properties of odourant molecule and smell perception
  - We do know that an odourant molecule must be small, have some fat solubility, and have a certain 3-D structure to effectively bind with a receptor.

Coding of olfactory signals:
- Coding strategies in olfactory processing:
  - Cross-fibre coding is supported because odourant receptors are capable of binding different odourants.
  - Label-line strategy is supported because it appears to be a precise anatomical relationship between receptor neurons and individual glomeruli in the olfactory bulb.
  - But, olfactory bulb also supports cross-fibre because a single odourant can activate several different glomeruli, and different sets of glomeruli produce different patterns of activation across the olfactory bulb.

Olfactory Detection and Sensitivity:
- Factors that affect detection thresholds:
  - Some gender differences have been found in terms of sensitivity to certain odourants that may be linked to hormones.
  - Increasing age is accompanied by a reduction in sensitivity.
  - Smoking increases thresholds for certain chemicals but not all.
  - Blind people are not more sensitive to different odourants, but they’re better at recognizing odours.

Detection and sensitivity:
- Abnormalities of olfactory function:
  - Considerable variability among humans
  - Hyposmia = reduced smell perception
  - Anosmia = total loss of all smell sensation
  - Specific anosmia = loss of smell for a particular odour

Suprathreshold olfactory function:
- Representation of odour quality:
  - Six categories of odourants = putrid, flowery, fruity, spicy, resinous, and burnt
  - Smell prism = represent all smell qualities using the six categories in a geometric form
  - Representation may be too simple

Suprathreshold olfactory function:
- Representation of odour quality:
  - Alternative is based on multidimensional scaling where two or more parameters are used in assessing various odours, and the odours are given a rating.
  - Suprathreshold intensity perception and odour recognition:
    - Discrimination tests used to study our ability to identify an odour
    - Magnitude estimation used to study perceived intensity of an odour
Suprathreshold olfactory function:

- Adaptation (ever been to Thurso?):
  - Continued exposure to an odour reduces our perceptual appreciation of it.
  - This produces temporary increases in detection threshold and reduces responses to suprathreshold sensations
- Cross-adaptation:
  - Sensitivity to one odourant is ALTERED by exposure to a different one.

Suprathreshold olfactory function:

- Perception of odour mixtures:
  - Doesn’t result in a simple addition of the component odourant intensities, but can produce suppression or masking effects
  - Can also blend together and create an entirely new fragrance, or the components can retain their individual qualities
  - Perceptual “binding” of olfactory stimuli (lemon pie, coffee, fish and chips…)

Suprathreshold olfactory function:

- Olfaction, emotion, and memory:
  - Olfactory structures linked to the amygdala and hippocampus, where emotional experience and memory traces are consolidated

Detection and sensitivity:

- Problems carrying out psychophysical measures:
  - No clear relationship between odourant chemistry and olfactory perception
  - Vast number of chemicals that yield different olfactory experiences
  - Susceptible to adaptation
  - Hard to control and deliver the stimulus
    - Use olfactometer
• Olfactory detection thresholds for sample odorants (ug/L)

<table>
<thead>
<tr>
<th>Odorant</th>
<th>Threshold (ug/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Musk</td>
<td>0.0007</td>
</tr>
<tr>
<td>Lemon</td>
<td>0.03</td>
</tr>
<tr>
<td>Vanilla</td>
<td>0.02</td>
</tr>
<tr>
<td>Rotten eggs</td>
<td>0.2</td>
</tr>
<tr>
<td>Bitter almond</td>
<td>3.0</td>
</tr>
<tr>
<td>Pencilsion</td>
<td>9.0</td>
</tr>
<tr>
<td>Banana</td>
<td>39.0</td>
</tr>
<tr>
<td>Wintergrein</td>
<td>100.0</td>
</tr>
</tbody>
</table>

• The common chemical sense:
  • Trigeminal chemoreception:
    • Separate system for detecting irritating chemicals
    • Free nerve endings in the olfactory epithelium that are stimulated by noxious chemicals, as well as pain and temperature

• The Vomeronasal system:
  • Used for detecting pheromones and other chemicals involved in chemical communication
  • A chemosensory pathway that exists in parallel to the main olfactory system
  • Vomeronasal organ (VNO – aka “Richardson’s organ”) is located on both sides of nasal septum in most terrestrial mammals, amphibians, and reptiles (in humans too?).
  • Sensory neurons of VNO send signals via vomeronasal nerve and synapse in the accessory olfactory bulb.
  • From here, projections are largely targeted to the limbic system, amygdala, and hypothalamus.

• Do humans have a functional vomeronasal system?
  • This is not entirely clear.
  • Structure similar to VNO is present at birth, but disappears by 5 months of age.
  • In adults, anatomical depression near nasal septum has been interpreted by some as a VNO.
  • Controversial.

• Flavour Perception:
  • Qualitative changes to the taste of substances when ingested in mixtures:
    • Basic question for flavour research: Is the quality of each individual taste retained in a flavour, or does an entirely new taste sensation arise?
    • Homogeneous mixtures show enhancement, while heterogeneous mixtures generally show suppression.
  • Interactions with other sensory systems:
    • Smell plays an important role in tasting, and taste identification drops if subjects are prevented from smelling.
    • Taste is also affected by other sensory modalities -- somatosensations, sight and hearing (as every good cook knows...)
Culinary experiences are the result of BOTH Olfaction and Gustation mechanisms.

- Food palatability is altered with decoupling of the oral and nasal cavity...
- Life-threatening disorders can result from gustatory abnormalities (e.g., salt blindness...)

Representing taste quality:
- Are all complex tastes the result of a mixture of the primaries, or is taste really a sensory continuum?
- Compelling arguments for both sides:
  - Cross-fibre theory difficult to reconcile with notion of taste primaries
  - Existence of taste primaries supported by neural considerations
- Multidimensional scaling shows that not all tastes are contained within the space of the classical primary qualities.
- Rating system is used for a set of taste descriptors.

The Challenge Explaining the Mechanism(s) of Flavour Perception

Explanations based on stereochemistry are not compelling (e.g., Amoore’s stereochemical Theory of odour) because there is no relationship between the chemical’s molecular appearance and what the chemical smells like...

EXAMPLE: The Vanilloids: molecules with obviously similar molecular structures but with distinctive flavours.
All contain a six-sided hexagonal ring of carbons (called a benzene ring). Subtle changes in the sizes or positions of groups of atoms attached to the ring dramatically change the compound’s flavor.

1. Zingerone, also called vanillylacetone, is a key component of the pungency of ginger. Similar in chemical structure to other flavor chemicals such as vanillin and eugenol. It is used as a flavor additive in spice oils and in perfumery to introduce spicy aromas.
2. Eugenol is used in perfumeries, flavorings, essential oils and in medicine as a local antiseptic and anesthetic.
3. Vanillin is used in pharmaceuticals, perfumes, as a food additive and flavouring
4. Capsaicin: the ‘hot’ in hot and spicy...

Applications:
- Food product comparison
- Wine, tea, whisky, coffee, marketing and blending
- Artificial flavour design
- Perfume design
- Pest repellant design
- Pharmacological design
- Medicine (diagnosis)
- Industrial environment control, air quality control
- Consumer and employee motivation

Consumer Perception of Cultured Yellow Perch (Perca flavescens) and Its Market Competitors
Delwiche, J.F., Liggett, R.E., and Wallat, G.

Aquaculturists are concerned with performance of cultured yellow perch against its wild-caught market competitors. In this study, consumer perception of cultured yellow perch was compared to that of wild-caught walleye, ocean perch, and zander. In 2 experiments, species were ranked for preference, rated for liking, and rated for degree of difference from a reference (cultured perch). Results were analyzed using Friedman’s analysis of ranks, analysis of variance, and method of maximum likelihood.
In Experiment 1 (n = 50), there was no significant difference in preference or liking, and all wild-caught species were significantly different from cultured perch in overall liking.
In Experiment 2 (n=68), the species were trimmed to the same thickness for a more fair comparison of these species. Cultured yellow perch was equally preferred to all species but was rated significantly higher in overall liking.
In addition, ocean perch and walleye were found to be significantly different from cultured perch, while zander was not.
Barbeque, sour cream and onion, salt and vinegar, nacho cheese, and salsa seasonings were applied to potato chips at 0 and 25 kV. Sensory evaluation determined that electrostatically coated chips had better coating uniformity and were significantly preferred to nonelectrostatically coated samples. Electrostatic coating was also more even as measured by colorimetry. Particle size and evenness of coating did not significantly affect perceived flavor intensity. Electrostatic coating significantly increased transfer efficiency and decreased dust over nonelectrostatic coating. Particle size and flowability can be used to predict transfer efficiency and dustiness. Chargeability was also important for electrostatic transfer efficiency. Particle size was the most important factor overall.

The effect of volatile compounds in white birch sticks obtained from four different geographical locations on the aroma of ice cream mix was investigated. Sensory evaluation, (specifically, a series of warmed-up paired comparisons) was conducted on stick-exposed ice cream mixes to see if aroma differences in those mixes could be detected. Batches of ice cream mix were exposed to the sticks and aged for 6 days at 4°C and then assessed by the panelists by pairwise comparison. Findings suggest that differences in aroma of mixes that have been exposed to white birch sticks from four different geographical origins can be distinguished perceptually.

Wine aroma is modified by the form of the wine glass. Healthy volunteers (43 m, 46 f, age 19-60 years) tried 3 glasses. Three glasses of different shape but of the same height and of comparable opening diameter were used. Glasses were “tulip”-like, “beaker”-like and “egg”-like shapes. Intensity, hedonic tone, and quality of a red wine were rated before and after drinking. Results: Both intensity and hedonic ratings of wines from different glasses were influenced by glass shape. Glass shape also influenced the complexity of wine odors. This appeared not to be related to the esthetic impression the glasses made. Conclusions: The present data indicate that egg-shaped glasses, compared to “tulip” or “beaker” glasses, appear to produce higher intensity and higher complexity of wine odors. This may relate to the trapping of odors in egg-shaped glasses.

Perfume design: blending natural chemistry to produce olfactory stimuli (for whom?)

Mixtures with 3 different time constants (short, medium and long):
- **Short time constant chemicals (“Top notes”):** These are scents perceived immediately on application of a perfume. Top notes consist of small, light molecules that evaporate quickly. They form a person’s initial impression of a perfume and thus are very important in the selling of a perfume. Also called the “head notes.”
- **Medium time constant chemicals (“Middle notes”):** The scent that emerges as the top notes dissipate, forming the “heart” or main body of a perfume. Middle notes mask the often unpleasant initial impression of base notes, which become more pleasant with time.
- **Long time constant chemicals (“Base notes”):** The scent of a perfume that appears closest to the departure of the middle notes. The base and middle notes together are the main theme of a perfume. Base notes bring depth and solidity to a perfume. Compounds of this class of scents are typically rich and “deep” and are usually not perceived until 30 minutes after application.

Fragrance Wheel perfume classification chart, c. 1983

2010 version

**Floral**
- Florals
- Soft Florals
- Floral Oriental

**Oriental**
- Soft Orientals
- Oriental
- Woody Oriental

**Woody**
- Woods
- Mossy Woods
- Dry Woods

**Aromatic**
- Fresh
- Citrus
- Fruity
- Green
- Water
The sub-groups of the fragrance wheel are:

- **Floral** (Floral + Fresh Notes). Main notes include fresh-cut flowers.
- **Soft Floral** (Floral Notes). Main notes include aldehydes and powdery notes.
- **Floral Oriental** (Floral + Oriental Notes). Main notes include orange blossom and sweet spices.
- **Soft Oriental** (Oriental + Floral Notes). Main notes include incense and amber.
- **Oriental** (Oriental Notes). Main notes include oriental resins and vanilla.
- **Woody Oriental** (Oriental + Woody Notes). Main notes include sandalwood and patchouli.
- **Woods**. Main notes include aromatic woods and vetiver.
- **Mossy Woods** (Woody + Oriental Notes). Main notes include oakmoss and amber.
- **Dry Woods** (Woody Notes). Main notes include dry woods and leather.
- **Citrus** (Woody + Fresh Notes). Main notes include bergamot and other citrus oils.
- **Fruity**. Main notes include berries and other non-citrus fruits.
- **Green** (Fresh Notes). Main notes include galbanum and green notes.
- **Water** (Fresh + Floral Notes). Main notes include marine and aquatic notes, generally from the chemical citral.

**Fougère**. The universal fragrance family whose scent includes elements from different families: the freshness of from the Citrus family, floral notes of lavender, the spicy-sweetness of a Floral Oriental, the ambery depth of an Oriental and the Mossy Woods warmth of sandalwood and oakmoss.

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**Tea blending:** additives to tea leaves and stems can include, flowers, roasted grains, herbs, spices, smoke, essential oils, flavourants or perfume.

**Flowers**

Although flowers are used to scent teas directly, most flower scented teas on the market utilize perfumes and aromas to augment or replace the use of flowers. The most popular of these teas include the flowers of the following:

- **Jasmine**: Spreads with jasmine flowers while oxidizing, and occasionally some are left in the tea as a decoration. Jasmine is most commonly used to flavour green teas to produce jasmine tea, although sometimes it is used to flavour light oolong teas such as baosheng tea.

- **Osmantus**: In China, osmanthus tea (called gui hu cha, 桂花茶) is produced by combining dried Sweet Osmantus (Osmantus fragrans) flowers (gui hu). This tea combines jasmine flowers with tea leaves – gives the tea a mild peach flavor. It is the second most popular scented tea (after Jasmine) in China.

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**Principles of “Artificial” Flavourings:**

Artificial Flavouring can:

- Duplicate an existing natural flavour (e.g., make whipped edible oil products taste more like ‘butter’).
- Add flavour to a product where none exists (e.g., gum, mouthwash, jelly beans).
- Give a product a distinctive flavor (e.g., cola, rootbeer).
- Add flavour to compensate for loss due to processing (e.g., whisky, wine, tea, etc.).
- Artificial flavours are typically composed of 3 types of chemicals:
  - **Character item**: Hexamyl acetate, impact groups: An amyl ester of acetic and propionic acids.
  - **Contributory items**: Ethyl-2-methylbutyrate, ethyl-3-methylbutyrate, and trans-2-hexenal, diacetyl.
  - **Differential items**: 2,5-dimethyl-4-hydroxy-3(2H)-furanone, diacetyl.

---

**Flavour Blending**

- Combining components in order to create favorable flavours...
- The golden rule of blending*: Successive blends of a product must taste the same as the previous one, so a consumer will not be able to detect a difference in flavour from one purchase to the next.

(What psychophysical method would you use to determine whether your blend meets the above criterion?)

*a corollary to ALL production quality control methods
Tea blending: Cont’d

Other flavorants

• Citrus oil: Best known of this class is Earl Grey tea. They are typically a mix of black teas with blends essential oils of the citrus fruit bergamot added.

• Smoke: The one type in this class is Lapsang Souchong, which is produced by drying black tea over smoking pine needles, which produces a striking smoky odor and flavor. The best varieties are not overwhelmed by the smoke, but retain subtlety and a mix of other flavors. Lapsang Souchong is found in many Russian Caravan blends.

• Spice: Tea such as Indian and Middle Eastern masala chai, flavoured with sweet spices such as ginger, cardamom, cinnamon, cassis, black pepper, clove, anise, fennel, Indian bay leaf and sometimes vanilla, nutmeg and mace. See also Kahwah.

• Rum: Jerigee is a tea with rum added.

• Roasted grain: Genmaicha, a Japanese tea with roasted rice added to green tea, and favoured by adherents of a macrobiotic diet. Wheat and barley are also used to blend with tea.

• Quince: when added to green tea, gives it a sweetish taste and scent.

Wine Quality: Olfactory and gustatory factors

Over 500 chemicals in red wine, (some affect taste, others smell):

Wine’s character is affected by a large number of physical factors:

• Geographic factors: soil chemistry, humidity, sun angle and intensity, mean daytime temperature, temperature distribution through the growing season, etc.

• Grape factors: specific varieties grown and blended

• Manufacturing factors: components used (grape skins, grape juice, stems, etc.), fermentation parameters, temperature, time, type of container (’oaking’ in casks, etc.).

Complexity of the process is reflected in the descriptive language used in wine appreciation...

What psychophysical methods are being used to evaluate the properties of this deodorant?

Why are all the observers women?

R & D at the deodorant factory...

‘Sniffer docs’ can be trained to detect diseases, too!

Unusual odors often serve as alerting signals for inborn errors of metabolism, including:

<table>
<thead>
<tr>
<th>Disease</th>
<th>Odour</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phenylketonuria (PKU)</td>
<td>animal-like</td>
</tr>
<tr>
<td>Maple syrup urine disease (MSUD)</td>
<td>maple syrup (sweet)</td>
</tr>
<tr>
<td>Isovaleric aciduria</td>
<td>acid</td>
</tr>
<tr>
<td>Glutaric aciduria Type II</td>
<td>short-chain acidic</td>
</tr>
<tr>
<td>Methionine malabsorption</td>
<td>cabbage</td>
</tr>
<tr>
<td>Tyrosinemia Type I</td>
<td>rancid butter</td>
</tr>
<tr>
<td>Dimethylglycinuria</td>
<td>unfresh fish</td>
</tr>
<tr>
<td>Trimethylaminuria</td>
<td>unfresh fish</td>
</tr>
</tbody>
</table>

Definitive diagnoses result from follow-on testing...
Evidence for the existence of VNO in humans

- Women can identify the smell of their birth children (but not stepchildren) from clothing samples...
- Men can discriminate the smell (of clothing) of ovulating females from non-ovulating controls
- Could these be explained by non-pheromonal olfactory stimuli?
- Have humans lost olfactory sensitivity due to bipedalism?
- Could perfume be an ‘scent amplifier’, to compensate for humans’ loss of olfactory sensitivity or loss of other sexual signals (such as reduced production of pheromones during estrus)?

Industrial Scenting Systems

The Sweet Smell of Success
At DMX We Believe in the Power of Scent.

“Nobel Prize-Winning Research Proved The Powerful Connection Between Scent And Memory
We all know the wrong aroma can send customers fleeing with sniffers pinched. Candles, plug-ins and other off-the-shelf products aren’t designed for business use.”

“DMX on-site scent solutions can be a powerful tool in your marketing arsenal. Many businesses are discovering this firsthand, capitalizing on the well-documented associative powers of smell – its ability to elicit vivid memories and emotions.”

“75 percent of emotions generated by smell, according to one recent study. Smell has been definitively linked to memory by Nobel Prize-winning research. So strong are smell associations that they can indeed alter moods, alleviate symptoms — even increase employee productivity.”

“Just think what it can do for your brand. DMX scents effectively harness this power to help you create a richer in-store experience while achieving your business goals.”

http://www.dmx.com/services/
http://www.koolfog.com/scenting-delivery-system/applications/

Scenting Delivery Systems

Applications for Scenting Systems
- Fragrance in Retail Environments,
- Training
- Presentations
- Scenting Systems for 4D-Cinema
- Scenting to Promote Food Products
- Enhancing Theming Using Fragrance
- Eliminating Foul Odors Using Fragrance
- Scent Branding in Resorts

http://www.koolfog.com/scenting-delivery-system/applications/

Chemical Hypersensitivity (Multiple Chemical Sensitivity):
- Many people experience ‘symptoms’ when exposed to fragrance chemistries (over 4000 chemicals are used in fragrance production).
- There are two main ways in which perfumes and their chemicals can enter the body – through direct contact with skin (and mucous membranes) and by inhalation.
- Chemical reactions affecting immunohistochemistry may be as minor as irritated eyes or as severe as anaphylaxis – an overwhelming allergic reaction that can lead to sudden death.
- Trend in public institutions to promote “scent-free” environments.

http://www.lung.ca