

What's That Smell



Learning Objectives

The sense of Smell

Odor characteristics and thresholds

Identifying and detecting “odor” compounds

The Fascinating World of Odors

- Human nose can distinguish ~10,000 different odors
- Humans have relatively few odor receptors (384)
 - But – cover same range
 - Less detail; human brain performs complex signal processing
- 1000x difference between least and most sensitive individuals





Food



Taste – nutritional content and possible presence of poisons

Taste Receptors

- Sweet → carbohydrates for energy
- Salt → electrolyte balance
- Savory → essential amino acids
- Sour → warning for fermentation
- Bitter → warning for poisons

Flavor is actually smell

- Ripe fruit – esters
- Poisons & bacterial contamination – amines and thiols
- Rotten fish – trimethylamine
- Bad milk – butyric acid



Survival



Natural sources

- Smoke
- Animal behavior
- Weather
- Some plants



Man-made sources

- Natural gas – thiol “cocktail”
- Exhaust fumes
- High chemical concentrations





Communication



Activities and Behaviors

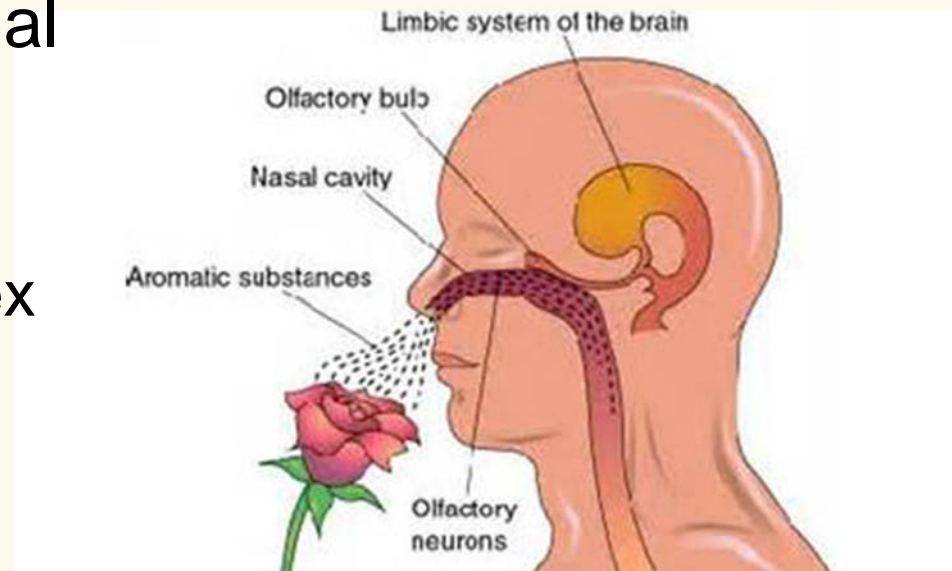
- Defense
- Protection
- Territory
- Emotion, e.g., fear
- Attraction

Sources

- Sweat
- Urine or feces
- Pheromones
- Glands
- Injury

What's in a Nose

- Volatiles enter nose
- Activate receptors
 - Odor-binding proteins
 - Complex sequence of biochemical reactions
- Generate electrical signal
- Transmitted to brain
 - Olfactory bulb
 - Primary olfactory cortex
 - Orbitofrontal cortex



If I Only Had a Brain ...

- Compared to previously “stored” patterns
 - Combined with other inputs
 - Interpreted as odor
-
- No fixed reference points
 - Character changes with concentration
 - Most odors comprised of many chemical compounds



Odor Characteristics and Thresholds



Terms

Odorant – substance capable of eliciting an olfactory response

Odor – sensation resulting from stimulation of the olfactory organs

Detection Threshold – 50% can identify presence of odor or odorant without characterizing it (smell something but can't say what it is)

Odor Threshold – concentration at which 50% of the individuals exposed to the odorant respond

Recognition Threshold – 50% identify odorant or odor

Odor Adaptation – process by which one becomes accustomed to odor

Odor Fatigue – total adaptation occurred through prolonged exposure

Odor Tenacity – persistence; time odor remains perceptible

What's the Difference: Odor vs Chemical

- Odors are perception of the physiological process
- Chemicals (VOCs) are what starts that process
- Odors and physical symptoms are both effects
- Odor compound may or may not be responsible for physical symptoms; there is no specific relationship linking the odor to other effects

Odor Detection

Physical conditions

- Volatility < ~18-20 carbons (light semi-volatile)
- Chemical structure
- Humidity



Individual conditions

- Age
- Medical conditions
- Smoking, alcohol
- Diet
- Occupation

Odor Threshold

Common chemical compounds

9 *	--	Sulfur dioxide
0.47	Rotten eggs	Hydrogen sulfide
210	Sulfide	Carbon disulfide
210	Green/sweet	Acetaldehyde
1000	Pungent	Formaldehyde
2.1	Pungent	Methyl mercaptan
47	Medicinal	Phenol
0.21	Fishy, pungent	Trimethyl amine
210	Burnt sweet	Acrolein

Odor Character

Different methods for determining character

- Musky – perfume/aftershave
- Putrid – rotten eggs
- Pungent – vinegar
- Camphor – mothballs
- Ethereal – dry cleaning
- Floral – roses
- Peppermint – minty

Strength

- Scale – 1 through 6

Identifying and Detecting “Odor” Compounds



Wet Dog



Combination of non “wet dog” odorants

almond	benzaldehyde
honey/floral	Phenylacetaldehyde
fruity/musty	Acetaldehyde
medicinal	Phenol
musty/nutty	2-methylbutanal
faecal	p-cresol
sulfurous	dimethyl trisulfide
mushroom	1-octen-3-ol
fruity	2-nonanone
earthy	2,3-diethyl-5-methylpyrazine

Coffee

1000s of chemical compounds
Only a few contribute to aroma

roasted (coffee)	2-furfurthiol
sulfurous, amine	3-methyl-2-buten-1-thiol
catty, roasted	3-mercapto-3-methylbutylformate
rotten cabbage	methanethiol
floral, spicy	methylpropanal
fruity, malty	3-methylbutanal
pungent, fruity	acetaldehyde
honey, fruity	b-damascenone
smoky, spicy	guaiacol
sweet, caramel	furaneol
earthy	2-isobutyl-3-methoxypyrazine
earthy, roasted	2-ethyl-3,5-dimethylpyrazine



Fresh-Cut Grass

Grass emits VOCs naturally

Certain VOCs increase when cut

- Defense
- Protection
- Infection



Specific VOCs

3-Hexenyl acetate

250 ppb odor threshold

3-Hexenal

Methanol

3-Hexen-1-ol

2-Hexenal

Testing for Odors

Sensory methods (sniff it)

- Concentration
- Intensity
- Character



Laboratory Methods

- Gas Chromatograph-Mass Spectrometer (GC-MS)
- Olfactometer
 - Device with a “smell” port
 - Paired with GC-MS
- Electronic “nose”



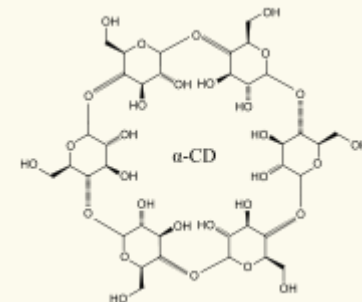
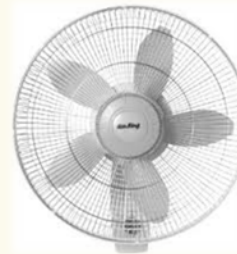
Treatment of Odors

Removal

Ventilation

Capture

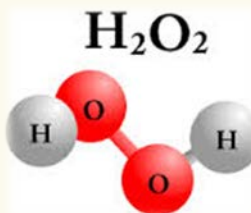
- Adsorption/Absorption
 - activated carbon
 - synthetic adsorbent polymers (e.g., Ambersorb)
 - baking soda (sodium bicarbonate)
 - ion exchange resins
 - microorganisms (somewhat selective)
- Encapsulation
- Blocking
 - sealer (e.g., epoxy, shellac, polyurethane, varnish, etc.)
 - masks, filters or nostril plugs



Treatment of Odors cont.

Conversion

- Chemical oxidation
 - sodium hypochlorite, hydrogen peroxide, ozone*
- Thermal oxidation
 - high heat
- Neutralizers



Deodorizing

- Air: aerosolizing, fuming, misting, adsorption and absorption
- Surface: cleaning, scrubbing, chemical and biological methods

Masking

- Addition of pleasant odor



Wrap Up

The sense of Smell

- Food, Survival, Communication
- The process
 - Volatiles enter nose
 - Activate receptors
 - Generate electrical signal
 - Transmit to brain
 - Brain “interprets” odor based on previous experiences

Odors are perception of the physiological process

Wrap Up

Odor characteristics and thresholds

- Odor Threshold: Odor detection → Odor recognition
 - < 1 ppb to 1000s of ppm
- Odor Character: Sweet; Floral; Pungent; Musky; etc.
- Odor compound may or may not be responsible for physical symptoms; there is no specific relationship linking the odor to other effects
 - Odors and physical symptoms are both effects

Wrap Up

Identifying and detecting “odor” compounds

- Most are mixture
- Same chemical compounds contribute to very different odors
- Lot of Treatment options
 - Remove
 - Ventilate
 - Capture
 - Convert
 - Deodorize
 - Mask

References

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Questions?

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