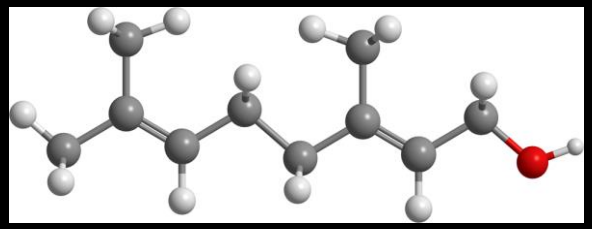
Plant Smells

and Molecules



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Carnation


Lemon blossoms


Smells of Ripe Fruits


Smells of Leaves ….
Lemon mint

Rosemary

Nutmeg,
Cloves,
Cinnamon

What Composes a Plant Smell??

MANY (50, 100, >200) different Compounds*.

Plant smells are **mixtures**.

Compounds
are composed of the
same type of molecules.

What Composes a Plant Smell??

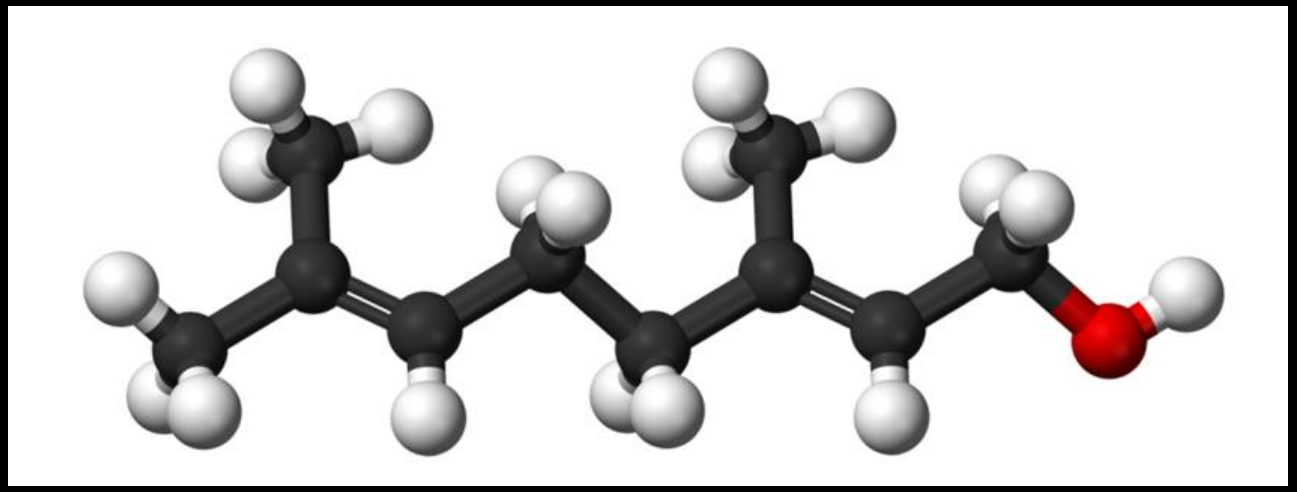
MANY (50, 100, >200) different

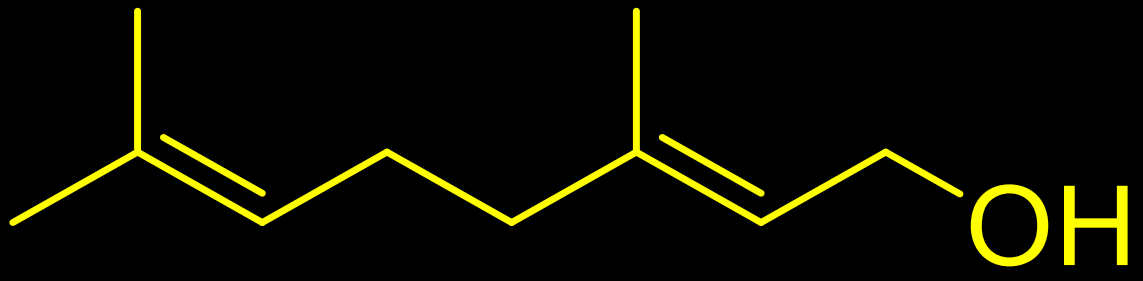
organic* (carbon-containing)

compounds

Rosa rugosa

Example of a Molecule of an **Organic** Compound

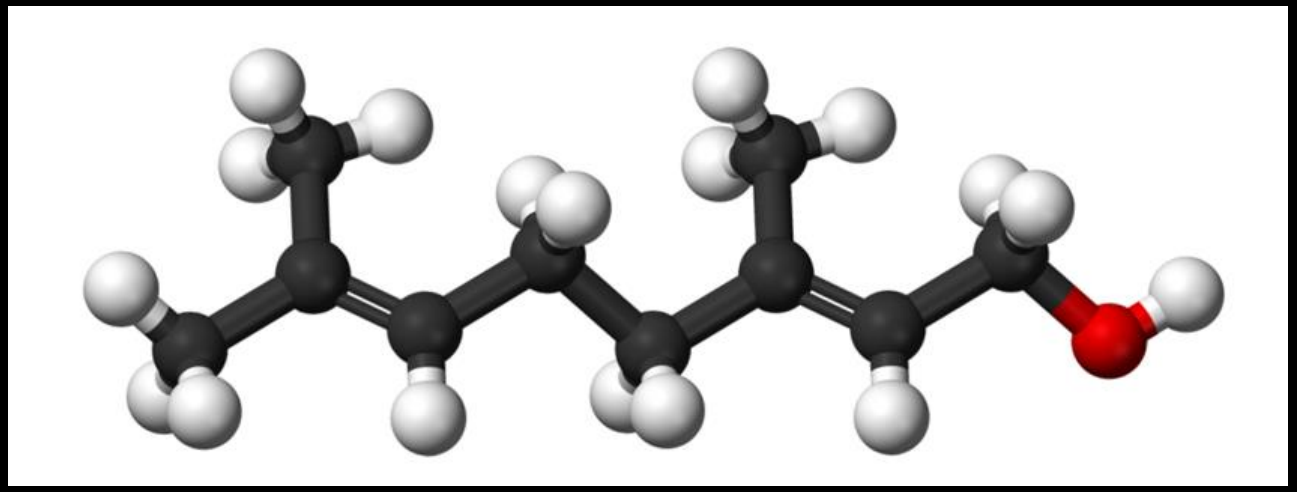


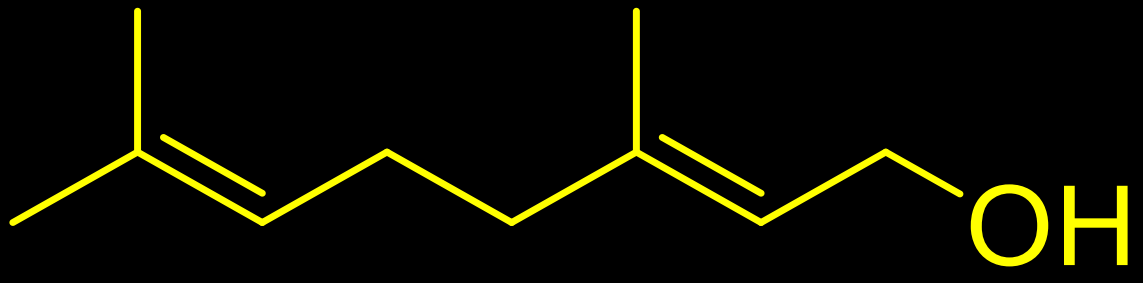


A molecule of
Geraniol $C_{10}H_{18}O$

Rosa rugosa

Example of a Molecule of an **Organic** Compound





Geraniol is a
sweet-smelling compound found in many flowers.

Periodic Table of the Elements

1																	18
1 H Hydrogen 1.01	2											13	14	15	16	17	2 He Helium 4.00
3 Li Lithium 6.94	4 Be Beryllium 9.01											5 B Boron 10.81	6 C Carbon 12.01	7 N Nitrogen 14.01	8 O Oxygen 16.00	9 F Fluorine 19.00	10 Ne Neon 20.18
11 Na Sodium 22.99	12 Mg Magnesium 24.31	3	4	5	6	7	8	9	10	11	12	13 Al Aluminum 26.98	14 Si Silicon 28.09	15 P Phosphorus 30.97	16 S Sulfur 32.06	17 Cl Chlorine 35.45	18 Ar Argon 39.95
19 K Potassium 39.10	20 Ca Calcium 40.08	21 Sc Scandium 44.96	22 Ti Titanium 47.88	23 V Vanadium 50.94	24 Cr Chromium 51.99	25 Mn Manganese 54.94	26 Fe Iron 55.85	27 Co Cobalt 58.93	28 Ni Nickel 58.69	29 Cu Copper 63.55	30 Zn Zinc 65.38	31 Ga Gallium 69.72	32 Ge Germanium 72.63	33 As Arsenic 74.92	34 Se Selenium 78.97	35 Br Bromine 79.90	36 Kr Krypton 84.80
37 Rb Rubidium 85.47	38 Sr Strontium 87.62	39 Y Yttrium 88.91	40 Zr Zirconium 91.22	41 Nb Niobium 92.91	42 Mo Molybdenum 95.95	43 Tc Technetium 98.91	44 Ru Ruthenium 101.07	45 Rh Rhodium 102.91	46 Pd Palladium 106.42	47 Ag Silver 107.87	48 Cd Cadmium 112.41	49 In Indium 114.82	50 Sn Tin 118.71	51 Sb Antimony 121.76	52 Te Tellurium 127.6	53 I Iodine 126.90	54 Xe Xenon 131.29
55 Cs Cesium 132.91	56 Ba Barium 137.33	57-71 Lanthanides	72 Hf Hafnium 178.49	73 Ta Tantalum 180.95	74 W Tungsten 183.85	75 Re Rhenium 186.21	76 Os Osmium 190.23	77 Ir Iridium 192.22	78 Pt Platinum 195.08	79 Au Gold 196.97	80 Hg Mercury 200.59	81 Tl Thallium 204.38	82 Pb Lead 207.20	83 Bi Bismuth 208.98	84 Po Polonium [208.98]	85 At Astatine 209.98	86 Rn Radon 222.02
87 Fr Francium 223.02	88 Ra Radium 226.03	89-103 Actinides	104 Rf Rutherfordium [261]	105 Db Dubnium [262]	106 Sg Seaborgium [266]	107 Bh Bohrium [264]	108 Hs Hassium [269]	109 Mt Meitnerium [278]	110 Ds Darmstadtium [281]	111 Rg Roentgenium [280]	112 Cn Copernicium [285]	113 Nh Nihonium [286]	114 Fl Flerovium [289]	115 Mc Moscovium [289]	116 Lv Livermorium [293]	117 Ts Tennessine [294]	118 Og Oganesson [294]

57 La Lanthanum 138.91	58 Ce Cerium 140.12	59 Pr Praseodymium 140.91	60 Nd Neodymium 144.24	61 Pm Promethium 144.91	62 Sm Samarium 150.36	63 Eu Europium 151.96	64 Gd Gadolinium 157.25	65 Tb Terbium 158.93	66 Dy Dysprosium 162.50	67 Ho Holmium 164.93	68 Er Erbium 167.26	69 Tm Thulium 168.93	70 Yb Ytterbium 173.06	71 Lu Lutetium 174.97
89 Ac Actinium 227.03	90 Th Thorium 232.04	91 Pa Protactinium 231.04	92 U Uranium 238.03	93 Np Neptunium 237.05	94 Pu Plutonium 244.06	95 Am Americium 243.06	96 Cm Curium 247.07	97 Bk Berkelium 247.07	98 Cf Californium 251.08	99 Es Einsteinium [254]	100 Fm Fermium 257.10	101 Md Mendelevium 258.10	102 No Nobelium 259.10	103 Lr Lawrencium [262]

Alkali Metal | Alkaline Earth | Transition Metal | Basic Metal | Metalloid | Nonmetal | Halogen | Noble Gas | Lanthanide | Actinide

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At “Elements” Art Exhibit, Marin Society of Artists, San Rafael

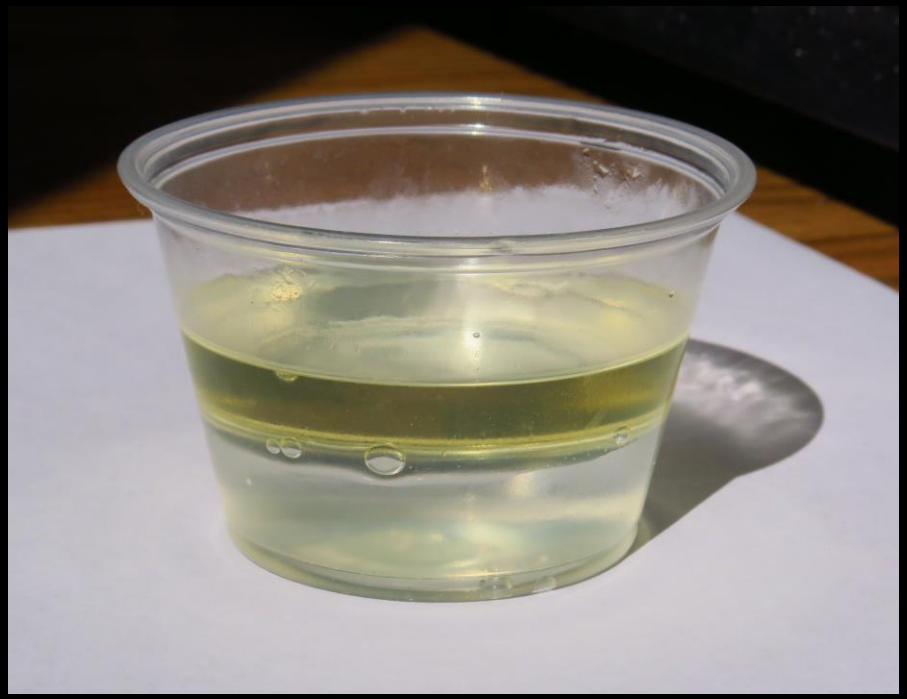
The Components of Plant Smells

are organic compounds that

- Are composed of molecules with a low number of C's (up to about 12)
- Evaporate easily (i.e. are volatile), especially on a warm days
- Are mostly nonpolar*, *i.e.* do not dissolve in water ("essential oils")

Compounds in Plant Smells

- are mostly nonpolar,
- *i.e.* they do not dissolve in water ("essential oils")



Oil on water

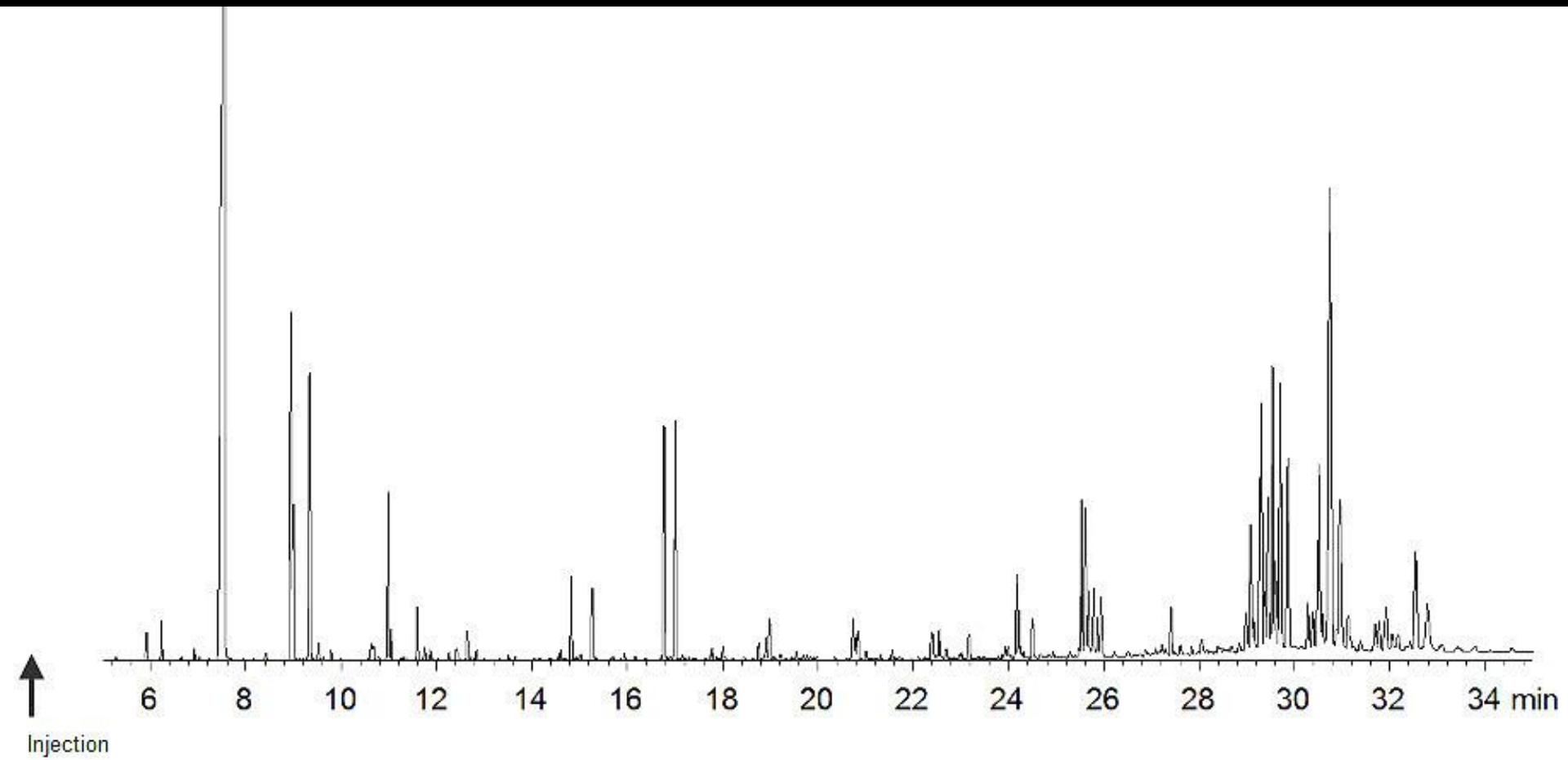
Plant smells are **mixtures*.**

Separating and Identifying Plant Smells:
Headspace Analysis/GC-MS

Headspace Analysis Display at Longwood Gardens PA

Collection of volatiles from fragrant flower
of an Ylang Ylang shrub (*Cananga odorata*)

Components of Rose Oil



Gas chromatogram of a rose oil

Compounds in the essential oil of *Rosa damascena* (% -age)

Determined by GC–MS Analysis

α-Pinene	1.46
2-Methyl propanol	0.01
Hexanal	tr
β-Pinene	0.13
Sabinene	0.04
Myrcene	0.18
δ-3-Carene	0.02
Heptanal	0.04
iso-Amyl alcohol	tr
Limonene	0.02
1,8-Cineole	tr

Citronellol	30.71
Nerol	7.57
2-Phenylethyl acetate	0.08
α-Cadinene	tr
cis-β-Damascenone	0.04
Geraniol	16.11
iso-Geraniol	0.19
Damascone	tr

In Citronella oil

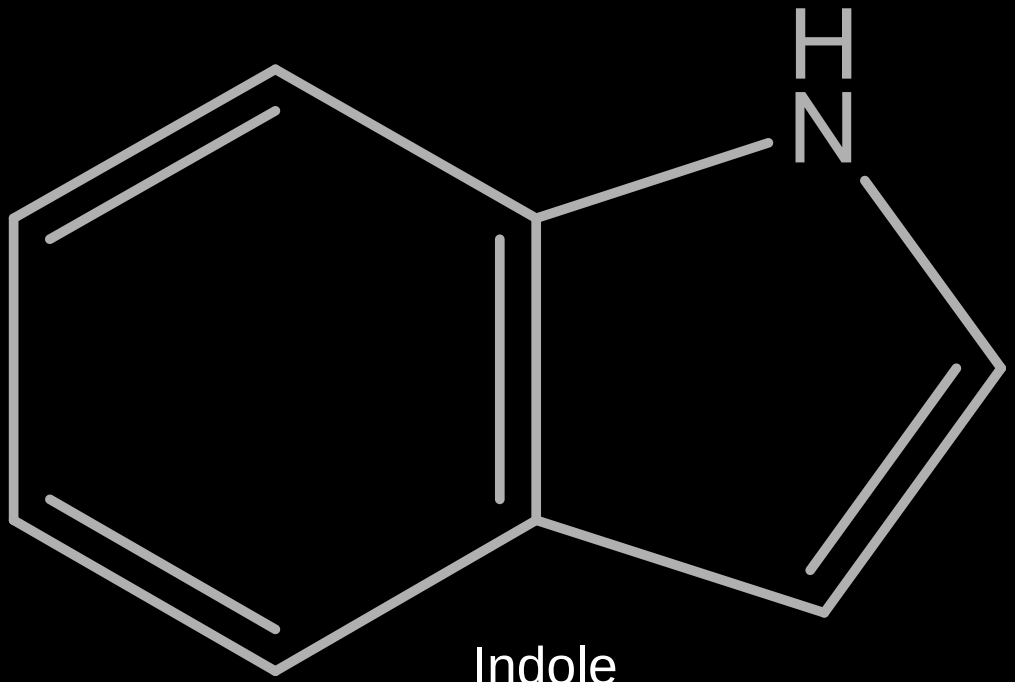
Citronellol $C_{10}H_{20}O$

In rose oil

Hyacinths

Table 2. 'Vacuum headspace' analysis of freshly picked white hyacinth flowers (two samples)

Peak no.	Constituents	GC area (%)	
		1	2
4	α-Pinene	0.08	0.16
5	Camphene	0.01	0.05
6	Hexanal	0.02	0.02
7	(*E*)-2-Methylbut-2-enal?	0.01	0.01
8	β-Pinene	0.06	0.05
9	Pent-1-en-3-ol	0.01	0.02
10	Myrcene	1.80	2.05
11	α-Phellandrene	Trace	0.01
15	Limonene	0.53	1.10
16	β-Phellandrene	0.01	0.01
17	1,8-Cineole	0.01	0.01
19	(*Z*)-β-Ocimene	0.75	1.01
21	(*E*)-β-Ocimene $C_{10}H_{16}$	13.72	14.93
136	(*E*)-Cinnamyl alcohol	4.04	3.46
139	2-(4-Methoxyphenyl) ethyl alcohol	—	Trace
145	Indole	0.05	0.08
150	Benzyl benzoate	3.06	2.94
153	β-Phenylethyl benzoate	0.53	0.40



Indole

C_8H_7N

Occurs naturally in human feces,
has an intense fecal odor.
At very low concentrations it has a flowery smell.

Stinky Flowers …

Amorphophallus titanum

Photo by Ch’ien C. Lee

Corpse flower
Rafflesia sp.

Plant compounds with pleasant or unpleasant scents

(from a human point of view!)

- Have typical chemical structures
- Pleasant:

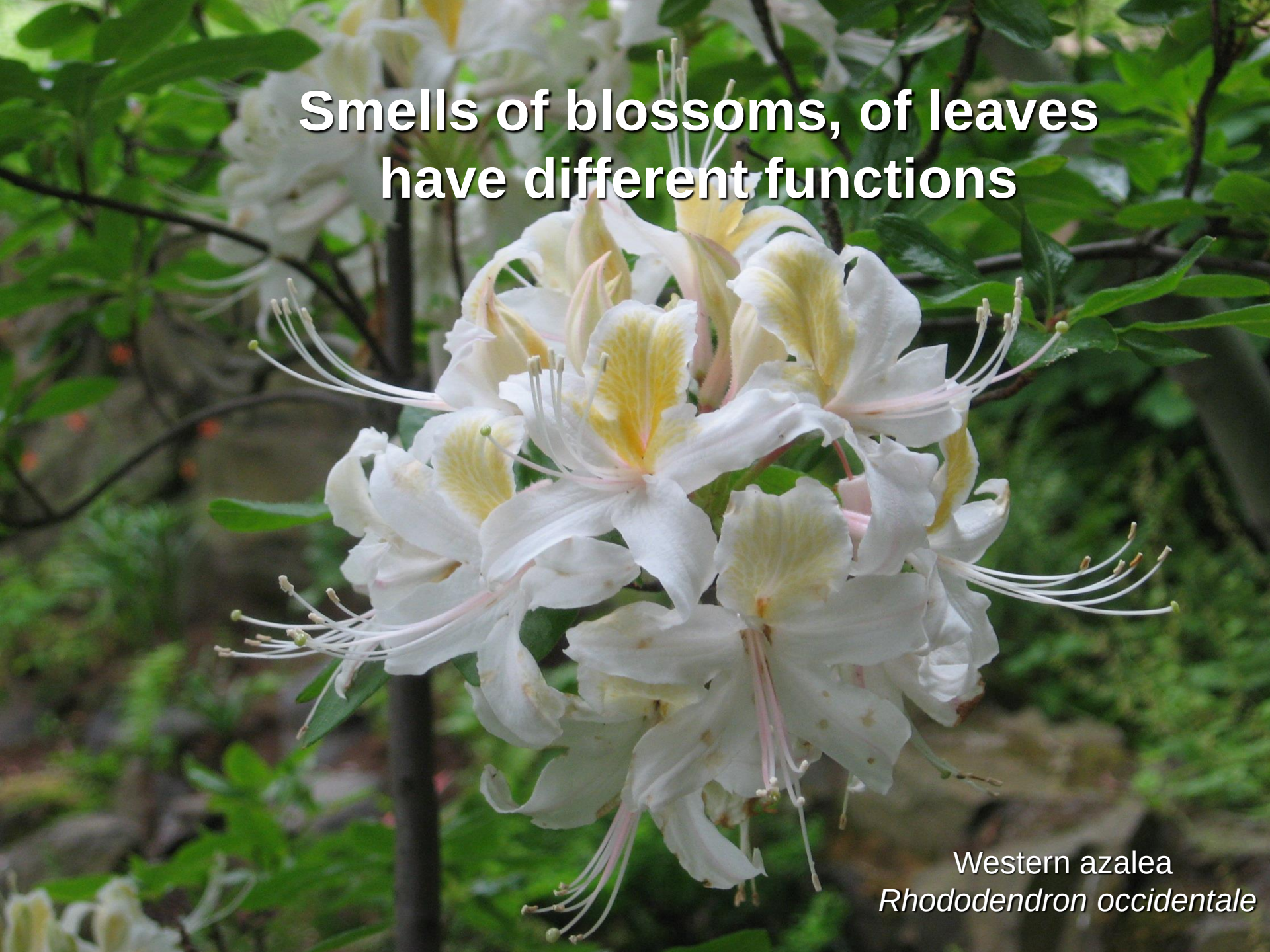
In flowers: attract bees, butterflies, moths, …

- Unpleasant: a wide range of volatiles that have nitrogen (N) or sulfur atoms (S) in their organic molecules.

In flowers: attract flies, beetles, gnats …

Western Spicebush
Calycanthus occidentalis


Western Spicebush
Calycanthus occidentalis


Smells of blossoms, of leaves
have different functions
Western azalea
Rhododendron occidentale

Smells of Leaves

California bay tree
Umbellularia californica

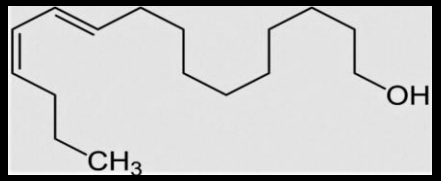
Human sense of smell

is affected by a person's age, sex, individual differences.

Humans have a broad range of sensitivity.

Humans are specially sensitive towards sulfurous smells. (Cooking gas…)

Human sense of smell compared …..



Bombykol $C_{16}H_{30}O$
pheromone

Silk moth (*Bombyx mori)*

CalACS Earth Day Booth at John Muir Ntl. Historic Park


VOTE
For your
smell


VOTE