Organic chemistry! Chapter 21

Nov 4 – Nov 8

Video 25: Organic Molecules and Skeletal Structure

Video 26: Nomenclature

Next week: Nov 11 – Nov 14 (not in these notes)

Video 27: Conformation of alkanes

Video 28: Functional groups

Video 29: Stereochemistry and isomers

Chapter 21

Nov 4 – Nov 8

Video 25: Organic Molecules and Skeletal Structure

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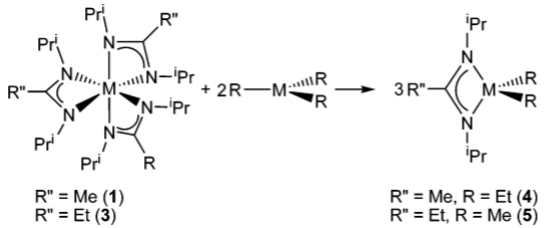
My diverse background in chemistry and biology

Inorganic chemistry



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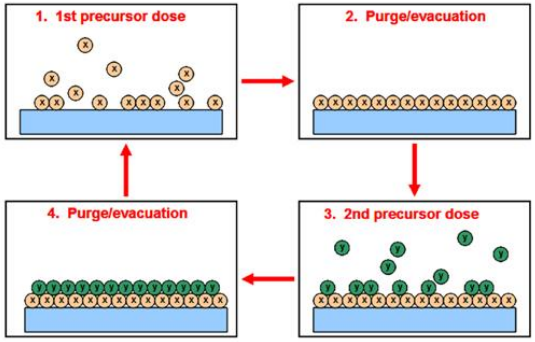
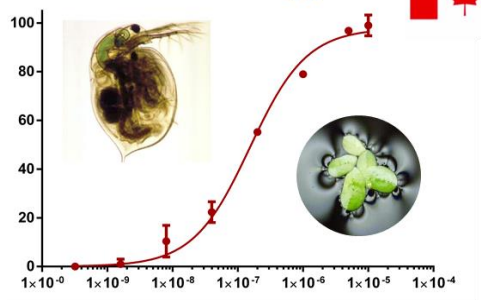
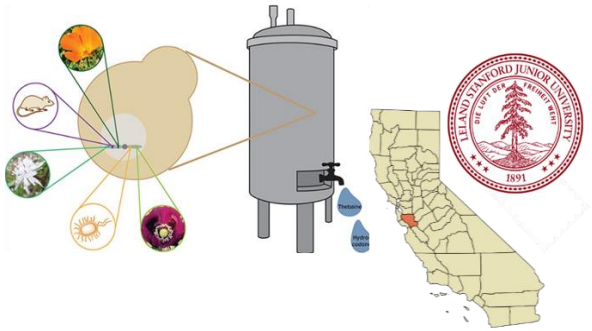


Toxicology

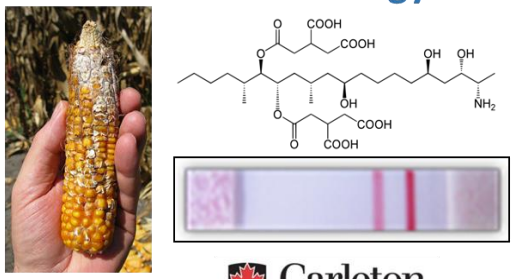
Natural Resources Canada



Biotechnology



DNA nanotechnology



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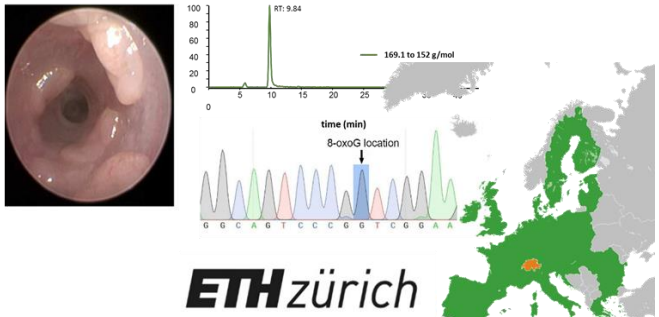
Chemical biology



ETH zürich

Intro to Organic Structures

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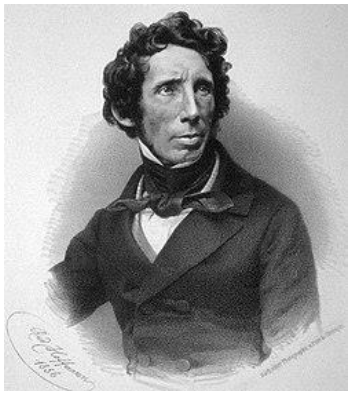
Birth of Synthetic Organic Chemistry

There was no concept of “synthesizing” compounds – compounds were separated and purified from natural sources



Friedrich Wohler: 1800-1882

“In a manner of speaking, I can no longer hold my chemical water. I must tell you that I can make urea without the use of kidneys of any animal, be it man or dog.”

Synthesized urea from ammonium cyanate in **1828**

-OCN	NH_4+	$CO(NH_2)_2$
Cyanate ion	Ammonium ion	Urea

Appearance:
White solid

Density:
1.32 g/cm3

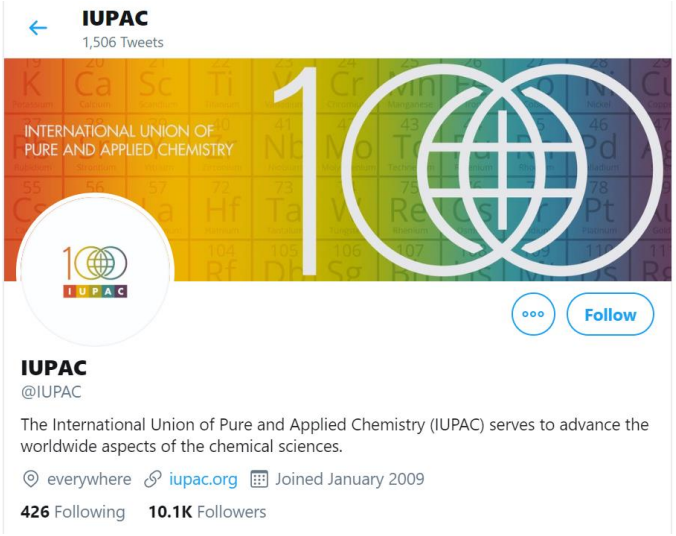
Melting point:
133 to 135 °C

Organic Chemistry – A Brief History

1892: International Congress of Chemistry developed "Geneva Nomenclature"

This remains the core (with continuous updates) of the IUPAC nomenclature that remains in use

(IUPAC = International Union of Pure and Applied Chemistry)



Learning organic chemistry

It’s hard work – it can be like learning a new language…

Imagine writing a poem or song

-memorize ABC’s
-memorize sounds
-learn words
-write sentences
-communicate your ideas in paragraphs, conversations

Why do we care about organic chemistry?

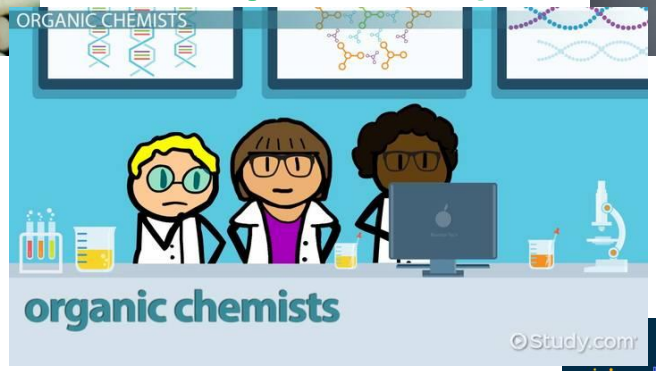
What do you care about?

Why do we care about organic chemistry?

Health

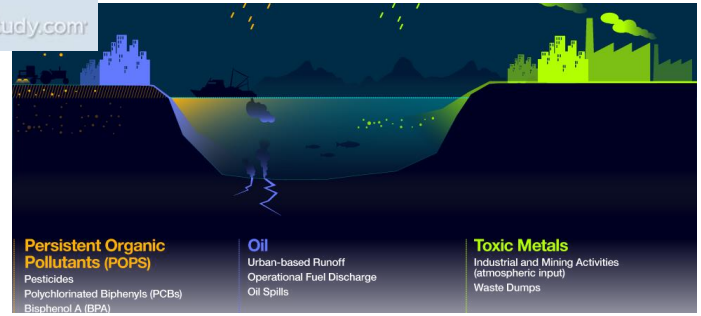
Synthesis (making new compounds)

Sports



Recreation

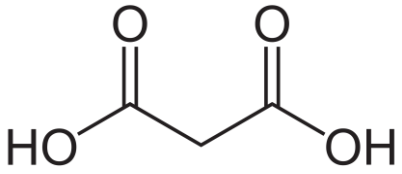
Environment



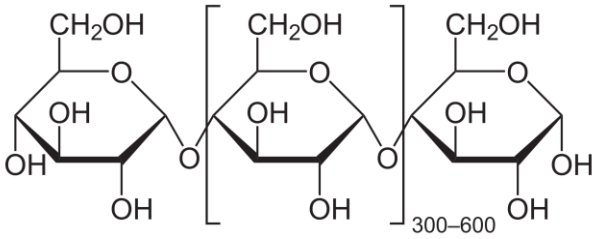
Video demonstration

The Briggs-Rauscher Reaction

$$IO_3^- + 2H_2O_2 + CH_2(CO_2H)_2 + H^+ \rightarrow ICH(CO_2H)_2 + 2O_2 + 3H_2O$$



Colour comes from iodine (and iodine binding to starch – which isn't even participating in the overall reaction!)

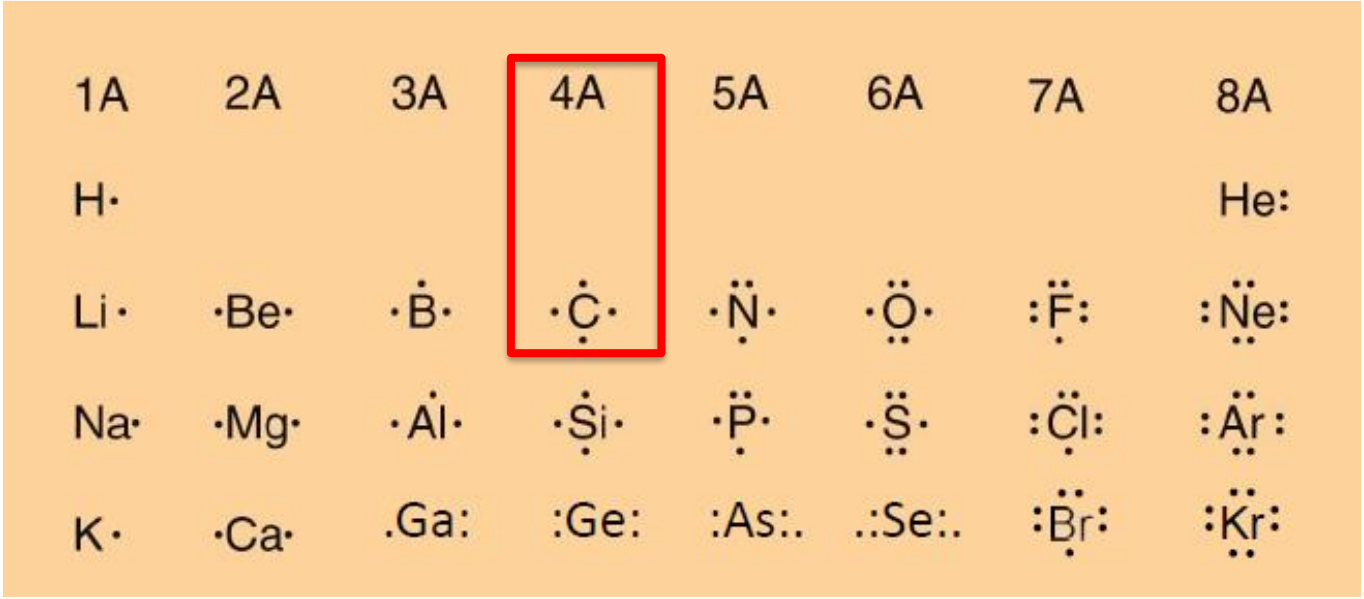


https://www.youtube.com/watch?v=WasYuiOk5xQ

NileRed

Why is carbon so special? Valence!

Review: Atoms lose/gain/share electrons to complete their octet – reach the noble gas configuration

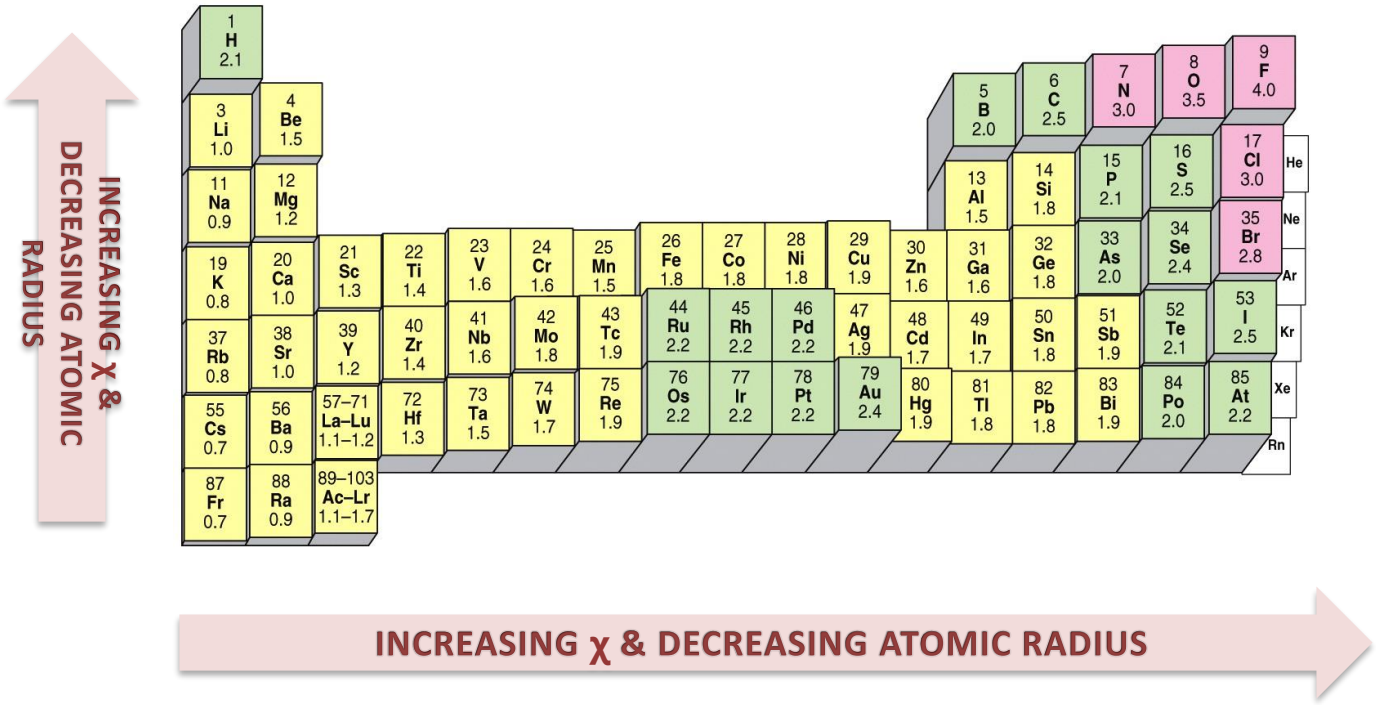


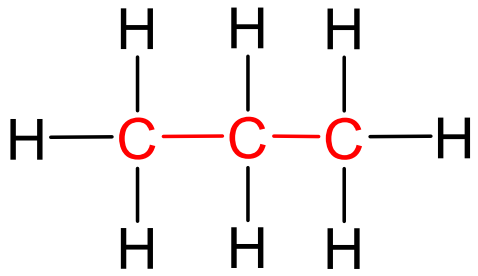
Carbon:

- Has 4 valence electrons
  - not realistic to be ionic (i.e. losing/gaining 4 is a lot)
  - Makes 4 bonds! (always!)

Hydrocarbons and electronegativity

Review: Electronegativity– ability of an element to attract bonding electrons





H—CH_3

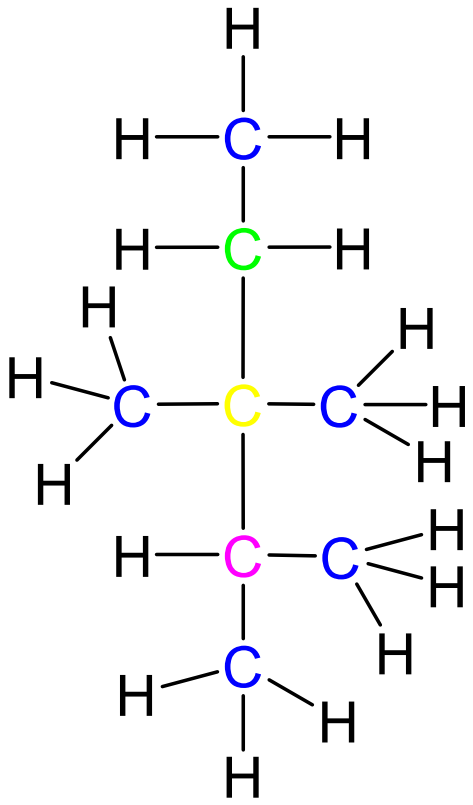
2.1 2.5

Δχ

0.4

Organic chemistry is a whole subject because there is so much bonding diversity possible

One example of a molecule with just H and C (hence the name hydrocarbons)



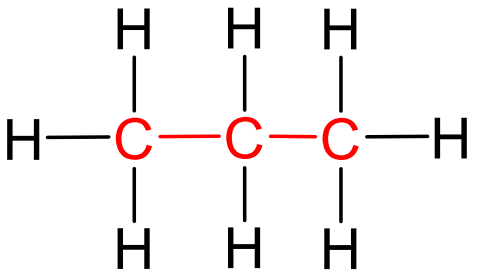
Primary carbon = a carbon that forms only 1 bond with another carbon

Secondary carbon = is bonded with 2 other carbons

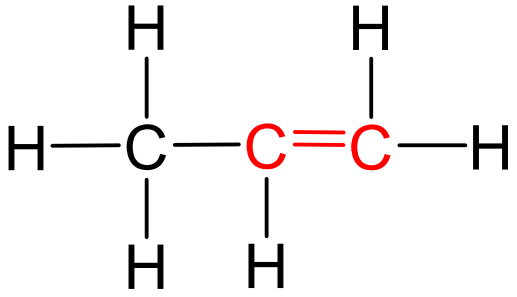
Tertiary carbon = is bonded with 3 other carbons

Quaternary carbon = is bonded with 4 other carbons

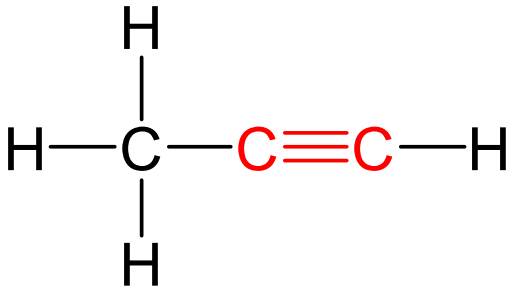
More Bonding Diversity in Organic Molecules



Single bond (also called **saturated**)
Saturated means “full” so a saturated molecule is full of bonds to as many other atoms as possible



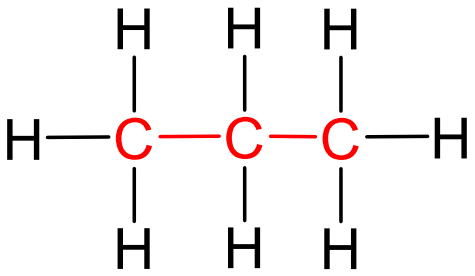
Double bond (unsaturated)

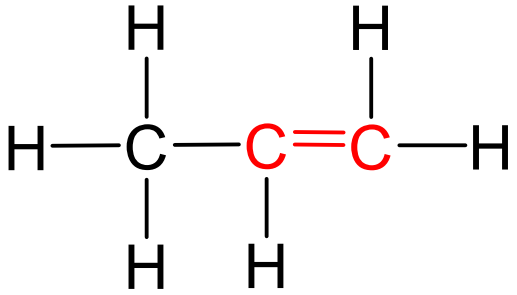


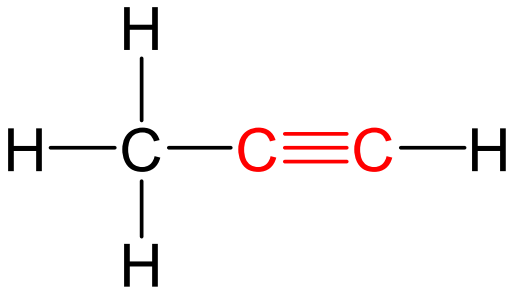
Triple bond (unsaturated)

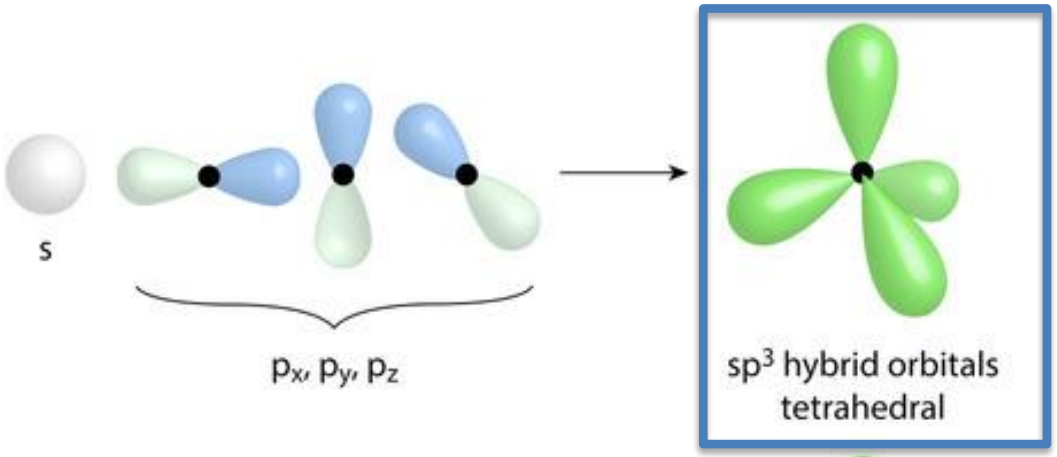
What exactly do you see for carbon hybridized orbitals?

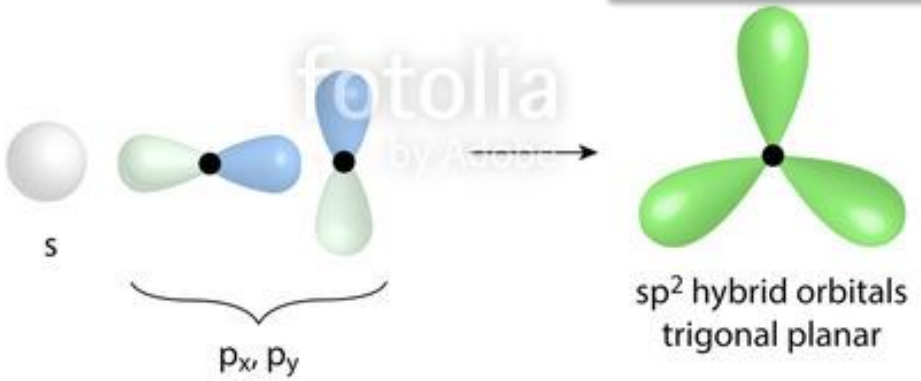
Bonding Diversity in Organic Molecules



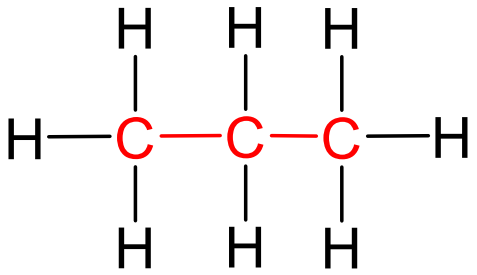


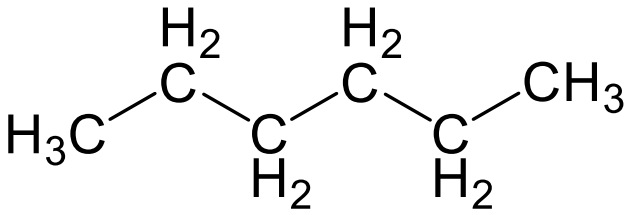


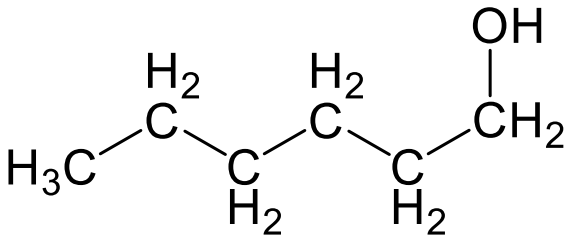




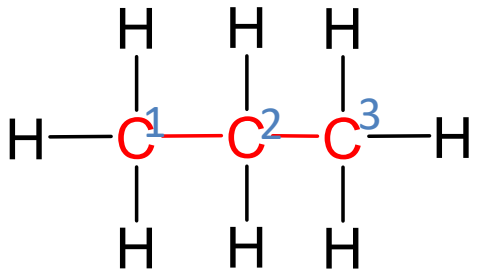
Simplifying Organic Compounds (Drawing)

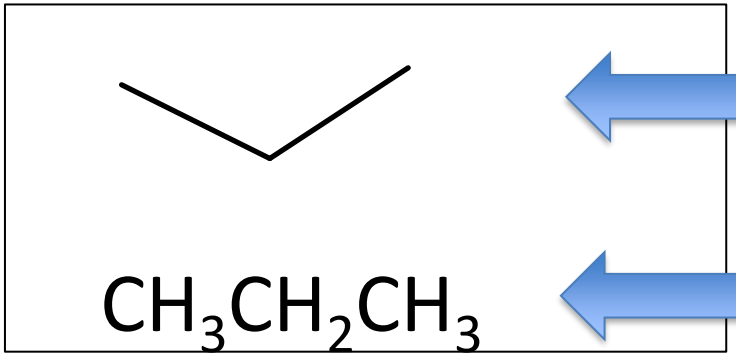






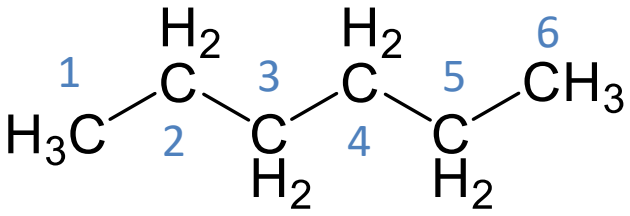
Simplifying Organic Compounds (Drawing)

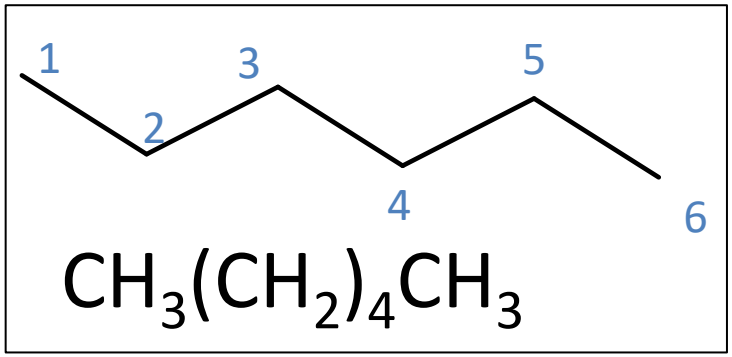


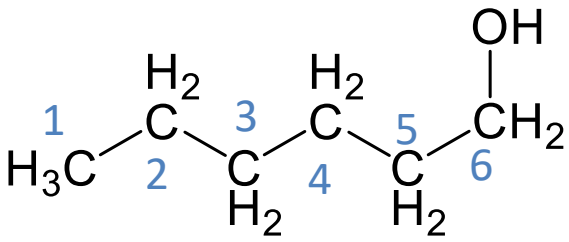


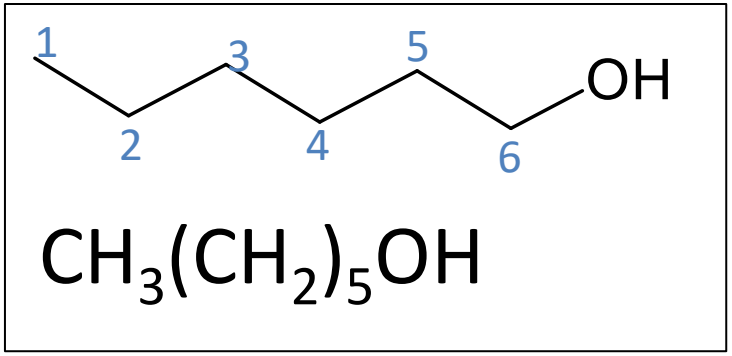
Skeletal diagram

Condensed



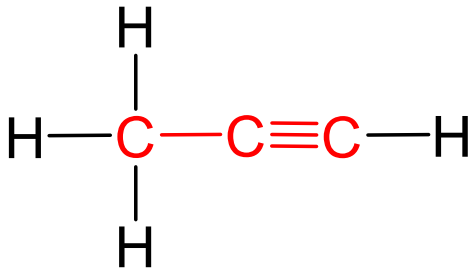




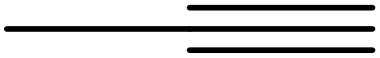


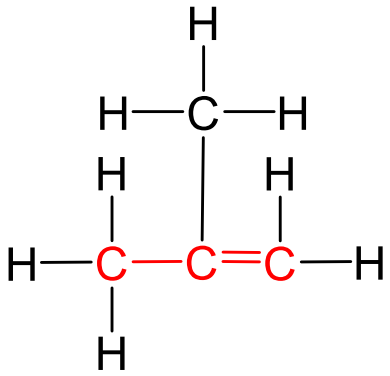
Have to write in all heteroatoms and anything attached to them at the end!

Bonding Diversity and Skeletal Structures

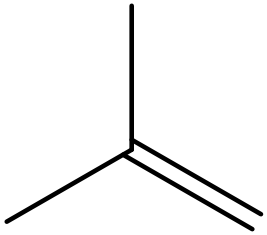


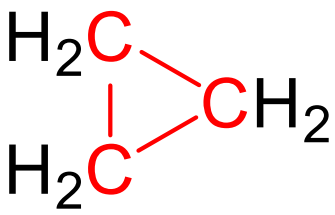
Triple bond is straight!



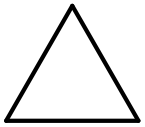


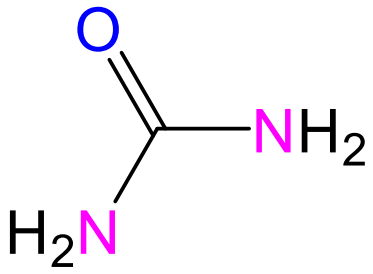
Branched chain





Cyclic Compound





Heteroatoms

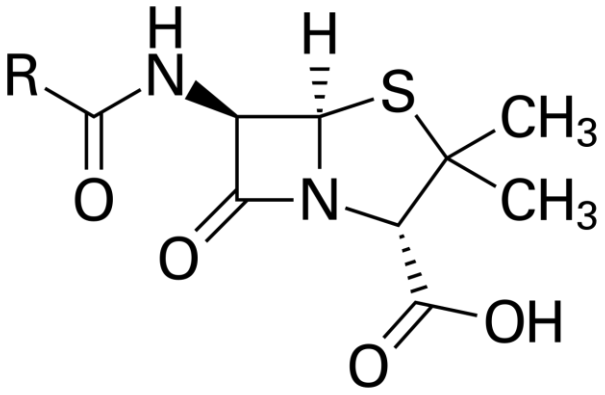
- Oxygen
- Nitrogen
- Phosphorus
- Sulfur
- Halides

Chapter 21

Nov 4 – Nov 8

Video 26: Nomenclature

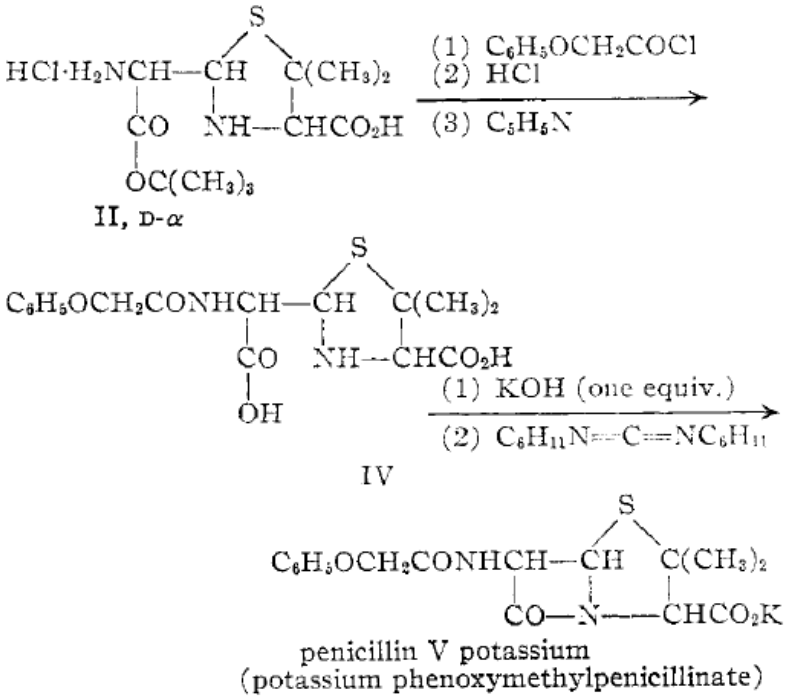
Importance of Organic Chemistry: Penicillin



Alexander Fleming discovered (its properties) in 1928

1) 1% yield by extracting from mold

Importance of Organic Chemistry: Penicillin



John C Sheehan and Kenneth R. Henery-Logan, **THE TOTAL SYNTHESIS OF PENICILLIN V.** *J. Am. Chem. Soc.* **1957**, *79*, 1262-1263.

2) "Total" chemical synthesis of penicillin

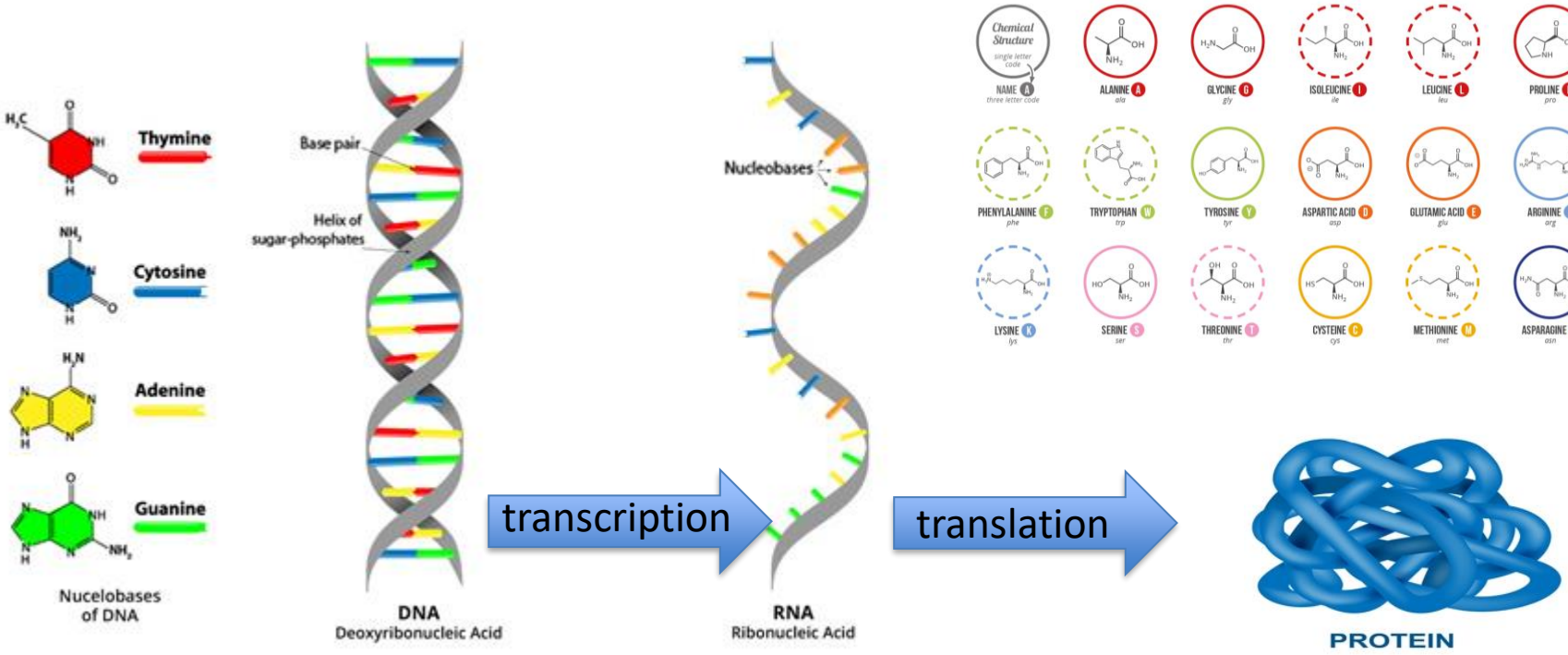
- 4 or more synthetic steps
- 0.6% yield

Importance of Organic Chemistry: Penicillin

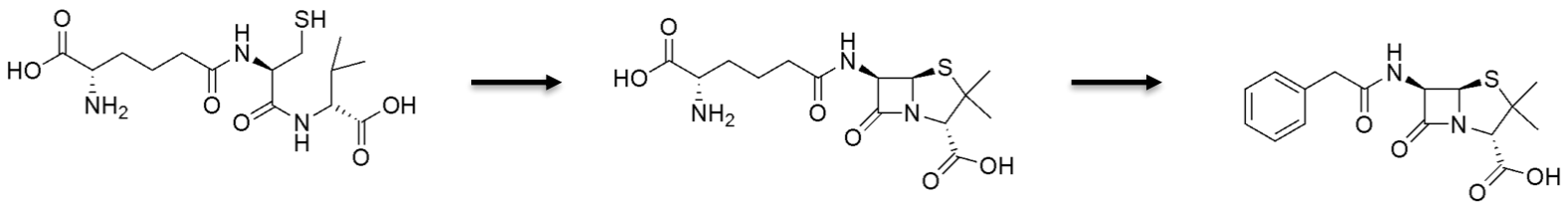
3) Production through fermentation (bioengineering/biotechnology)

- 10% yield!

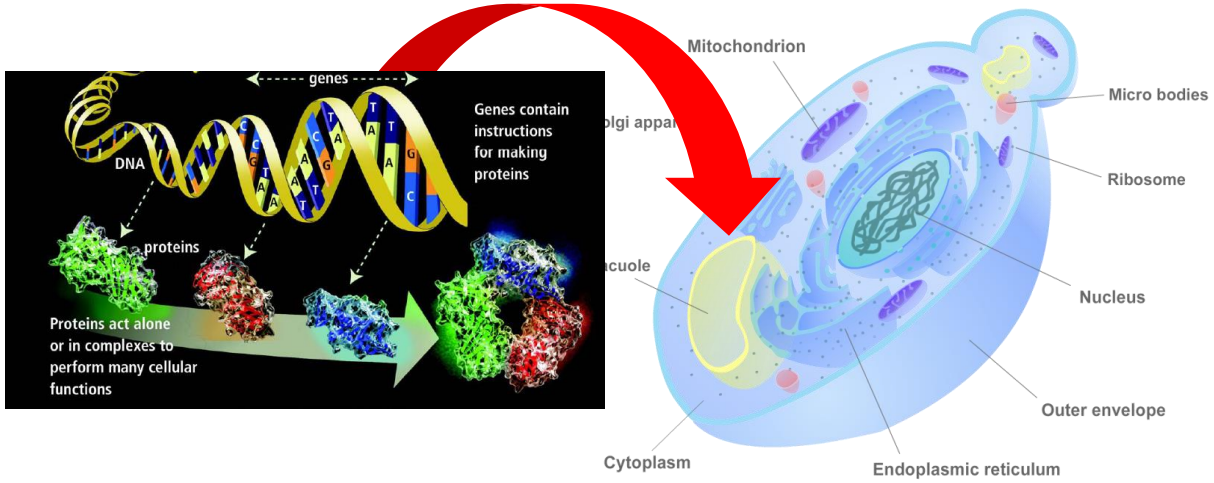
Importance of Organic Chemistry

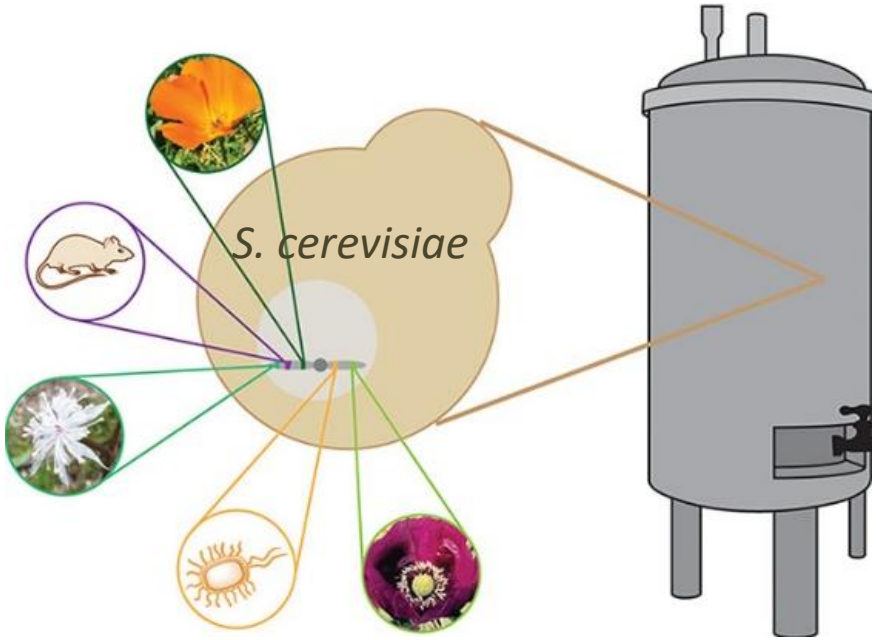


Enzymes (proteins) do the chemical synthesis!



Importance of Organic Chemistry





biofuels

biomaterials

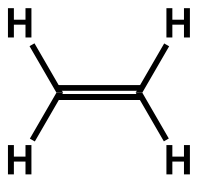
pharmaceuticals

Nomenclature, physical properties, and chemical properties: **Group similar organic compounds together**

HYDROCARBONS

Saturated
Alkane

Suffix: **-ane**



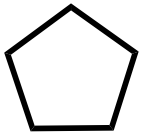
Unsaturated
Alkene (double bond)

Suffix: **-ene**

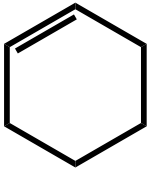
Unsaturated
Alkyne (triple bond)

Suffix: **-yne**

CYCLIC HYDROCARBONS

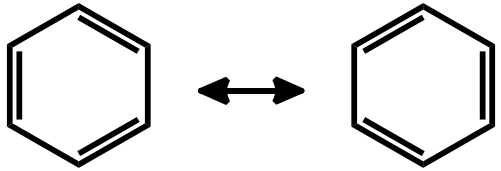


Cycloalkane



Cycloalkene

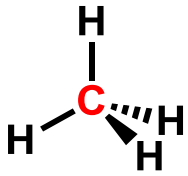
AROMATICS (BENZENE RINGS)



Nomenclature: Saturated hydrocarbons: Alkanes (–ane)

Simplest Alkane: CH_4

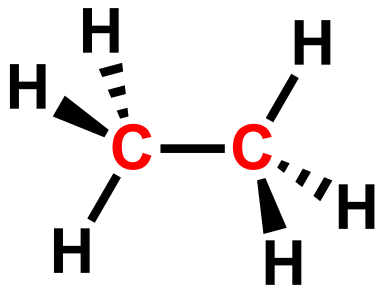
CH_4



METHANE

Nomenclature: Saturated hydrocarbons: Alkanes (–ane)

CH_4	METHANE	CH_4
CH_3CH_3	ETHANE	C_2H_6



Nomenclature: Saturated hydrocarbons: Alkanes (–ane)

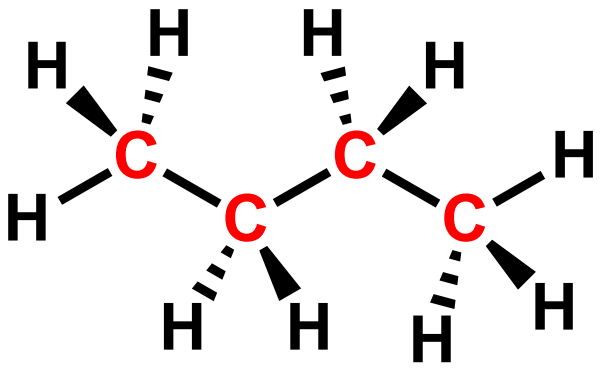
CH_4	METHANE	CH_4	n=1
CH_3CH_3	ETHANE	C_2H_6	n=2
$CH_3CH_2CH_3$	PROPANE	C_3H_8	n=3

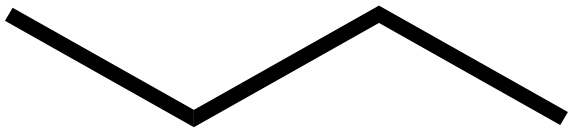
A trend in alkane molecular formula

C_nH_{2n+2} : Saturated hydrocarbon

Nomenclature: Saturated hydrocarbons: Alkanes (–ane)

CH_4	METHANE	CH_4
CH_3CH_3	ETHANE	C_2H_6
$CH_3CH_2CH_3$	PROPANE	C_3H_8
$CH_3CH_2CH_2CH_3$	BUTANE	C_4H_{10}



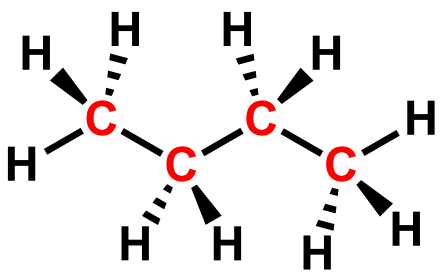


Nomenclature: Saturated hydrocarbons: Alkanes (–ane)

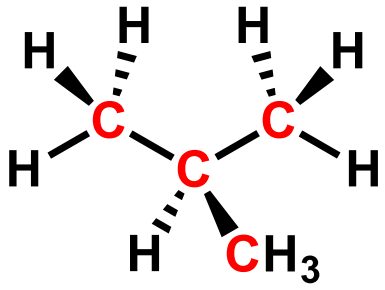
CH_4	METHANE	CH_4
CH_3CH_3	ETHANE	C_2H_6
$CH_3CH_2CH_3$	PROPANE	C_3H_8
$CH_3CH_2CH_2CH_3$	BUTANE	C_4H_{10}

NOTICE a pattern:

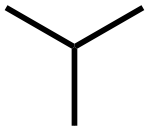
$$C_nH_{2n+2}$$



BUTANE



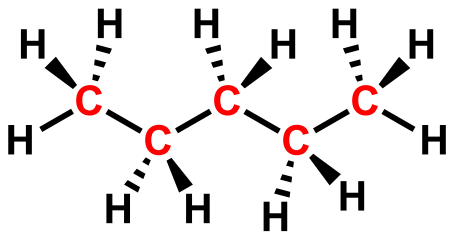
ISO BUTANE



Same molecular formula : C_4H_{10} – but different structures/bonding – **Skeletal ISOMERS**

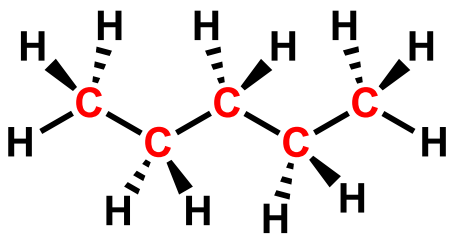
Nomenclature: Saturated hydrocarbons: Alkanes (–ane)

CH_4	METHANE	CH_4
CH_3CH_3	ETHANE	C_2H_6
$CH_3CH_2CH_3$	PROPANE	C_3H_8
$CH_3CH_2CH_2CH_3$	BUTANE	C_4H_{10}
$CH_3(CH_2)_3CH_3$	PENTANE	C_5H_{12}

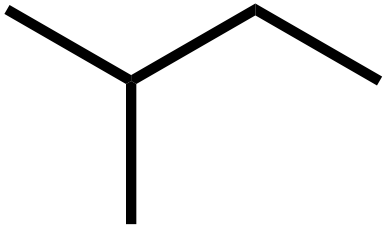


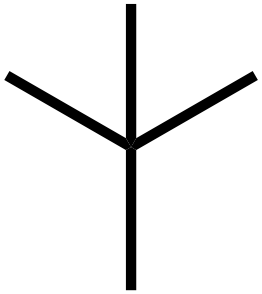
Nomenclature: Saturated hydrocarbons: Alkanes (–ane)

CH_4	METHANE	CH_4
CH_3CH_3	ETHANE	C_2H_6
$CH_3CH_2CH_3$	PROPANE	C_3H_8
$CH_3CH_2CH_2CH_3$	BUTANE	C_4H_{10}
$CH_3(CH_2)_3CH_3$	PENTANE	C_5H_{12}



Same molecular formula : C_5H_{12} – but different structures/bonding – STRUCTURAL ISOMERS (later you will see these are specifically skeletal isomers)





Nomenclature Saturated hydrocarbons Alkane Base Names

You need to memorize the prefix!

CH_4	METHANE	CH_4
CH_3CH_3	ETHANE	C_2H_6
$CH_3CH_2CH_3$	PROPANE	C_3H_8
$CH_3CH_2CH_2CH_3$	BUTANE	C_4H_{10}
$CH_3(CH_2)_3CH_3$	PENTANE	C_5H_{12}
$CH_3(CH_2)_4CH_3$	HEXANE	C_6H_{14}
$CH_3(CH_2)_5CH_3$	HEPTANE	C_7H_{16}
$CH_3(CH_2)_6CH_3$	OCTANE	C_8H_{18}
$CH_3(CH_2)_7CH_3$	NONANE	C_9H_{20}
$CH_3(CH_2)_8CH_3$	DECANE	$C_{10}H_{22}$

Saturated hydrocarbons: Alkanes (–ane) ($\mathbf{C_nH_{2n+2}}$)

CH_4	METHANE	CH_4	GASES
CH_3CH_3	ETHANE	C_2H_6	
$CH_3CH_2CH_3$	PROPANE	C_3H_8	
$CH_3CH_2CH_2CH_3$	BUTANE	C_4H_{10}	
$CH_3(CH_2)_3CH_3$	PENTANE	C_5H_{12}	LIQUIDS
$CH_3(CH_2)_4CH_3$	HEXANE	C_6H_{14}	
$CH_3(CH_2)_5CH_3$	HEPTANE	C_7H_{16}	
$CH_3(CH_2)_6CH_3$	OCTANE	C_8H_{18}	
$CH_3(CH_2)_7CH_3$	NONANE	C_9H_{20}	
$CH_3(CH_2)_8CH_3$	DECANE	$C_{10}H_{22}$	

Comparing Physical Properties of Alkanes

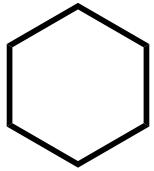
Hydrocarbons are regarded as **non-polar** (the difference in electronegativity between C and H is very small).

The only intermolecular force present in hydrocarbons is **London Dispersion Force**

Alkanes: become *less volatile with increasing molar mass*.

Nomenclature: Cyclic hydrocarbons: cycloalkanes (C_nH_{2n})

HEXANE C_6H_{14} 

CYCLOHEXANE C_6H_{12} 

Just put "cyclo" in front of the alkane name

Cycloalkanes (cycloxxxane)

METHANE CH_4 = can't make a circle

ETHANE C_2H_6 = can't make a circle

PROPANE C_3H_8 =  cyclopropane = C_3H_6

BUTANE C_4H_{10} =  cyclobutane = C_4H_8

PENTANE C_5H_{12} =  cyclopentane = C_5H_{10}

HEXANE C_6H_{14} = etc, fill in the blanks!

HEPTANE C_7H_{16}

OCTANE C_8H_{18}

NONANE C_9H_{20}

DECANE $C_{10}H_{22}$

NOTICE a pattern:

C_nH_{2n}

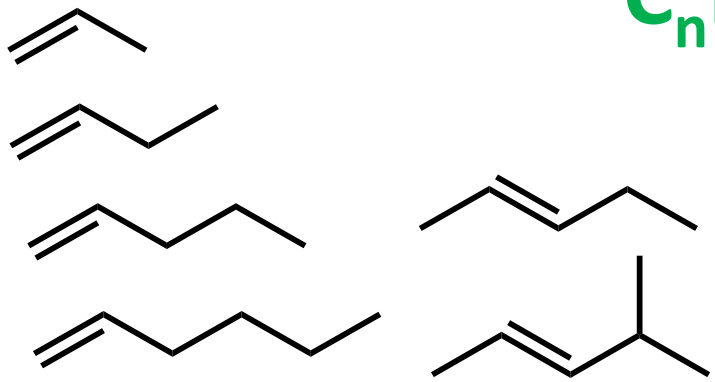
Nomenclature: Alkenes (C_nH_{2n}) – Base names

Same prefix (eth, prop, but…) different suffix!
-Change to “ene” instead of “ane”

NOTICE a pattern:

C_nH_{2n}

ETHENE	C_2H_4
PROPENE	C_3H_6
BUTENE	C_4H_8
PENTENE	C_5H_{10}
HEXENE	C_6H_{12}
HEPTENE	C_7H_{14}
OCTENE	C_8H_{16}



Many structural isomers possible

Physical Properties of Alkenes

ETHENE	C_2H_4
PROPENE	C_3H_6
BUTENE	C_4H_8
PENTENE	C_5H_{10}
HEXENE	C_6H_{12}
HEPTENE	C_7H_{14}
OCTENE	C_8H_{16}

Nomenclature: Alkynes (C_nH_{2n-2})

Same prefix (eth, prop, but…) different suffix!
-Change to "yne" instead of "ane"

CH≡CH	ETHYNE	C_2H_2
CH≡CCH$_3$	PROPYNE	C_3H_4
CH≡CCH$_2$CH$_3$	BUTYNE	C_4H_6
CH≡C(CH$_2$)$_2$CH$_3$	PENTYNE	C_5H_8
CH≡C(CH$_2$)$_3$CH$_3$	HEXYNE	C_6H_{10}
CH≡C(CH$_2$)$_4$CH$_3$	HEPTYNE	C_7H_{12}
CH≡C(CH$_2$)$_5$CH$_3$	OCTYNE	C_8H_{14}
CH≡C(CH$_2$)$_6$CH$_3$	NONYNE	C_9H_{16}
CH≡C(CH$_2$)$_7$CH$_3$	DECYNE	$C_{10}H_{18}$

NOTICE a pattern:

C_nH_{2n-2}

Degrees or units of unsaturation

How to calculate for any unsaturated molecule:

1) Calculate difference in # of hydrogens for the saturated version of the molecule vs the molecule at hand.
2) Divide the difference by 2

Example 1: How many degrees of unsaturation in octyne?

OCTYNE C_8H_{14} = 14 hydrogens in molecule of interest

What is the formula for a fully saturated version of a C8 “oct” molecule?

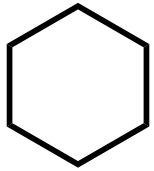
C_8H_{18} = so 18 hydrogens if the molecule was saturated

1) So, 18-14 = 4
2) 4/2 = 2

Therefore this molecule has 2 units of unsaturation

How many units of unsaturation in cyclohexane?

HEXANE C_6H_{14} 

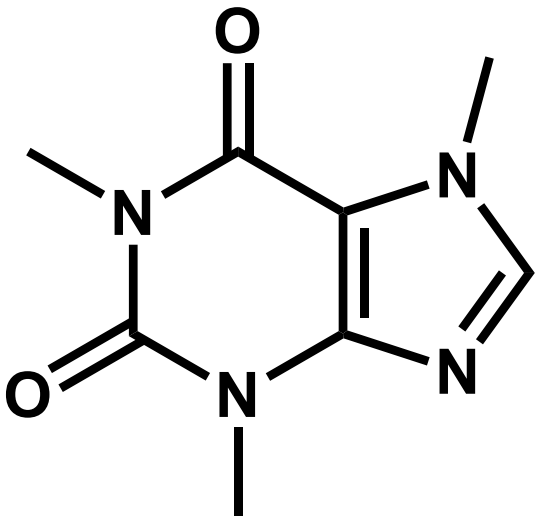
CYCLOHEXANE C_6H_{12} 

CHAINED alkanes (not cycloalkanes) have the maximum hydrogen per C (saturated)

1) So, 14-12 = 2
2) 2/2 = 1

Therefore this molecule has 1 unit of unsaturation

How to calculate units of unsaturation for more complex molecules.



caffeine

MEMORIZE THE FOLLOWING

1. Double bond – 1 unit of unsaturation
2. Triple bond – 2 units of unsaturation
3. Each ring – 1 unit of unsaturation

4 double bonds; 2 rings

Units of unsaturation = 4+2 =6

IUPAC Nomenclature: For complicated organic compounds

need to memorize these rules (or practice practice practice!)

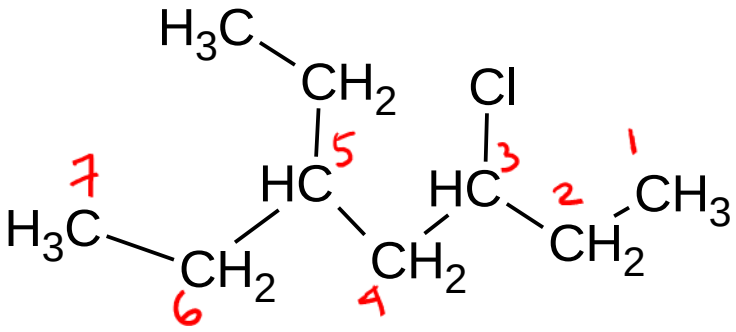
For alkanes and their derivatives

1. Find the longest carbon chain. Use that number as the prefix + "ane" as the base name.
2. Number the carbons in the chain from the end nearest the first branch/substituent. (If there is a tie, give the lowest number to the lowest in alphabetical order – i.e. ethyl lower than methyl)
3. Identify substituents (e.g. methyl, ethyl, bromo, chloro). If more than one substituent of the same kind is present, use the prefixes "di" for two, "tri" for three, "tetra" for four….
4. Locate the numbered carbon to which the substituents are attached.
5. Put substituents in alphabetical order (multiplier prefixes like "di", "tri" do not count).
6. Separate numbers from letters by a dash and write the whole name as one word with the basic name at the end.

IUPAC Nomenclature : For complicated organic compounds

For **alkanes** and their derivatives

1. Find the longest carbon chain. Use that number as the prefix + “ane” as the base name.
2. Number the carbons in the chain from the end nearest the first branch/substituent. (If there is a tie, give the lowest number to the lowest in alphabetical order – i.e. ethyl lower than methyl)

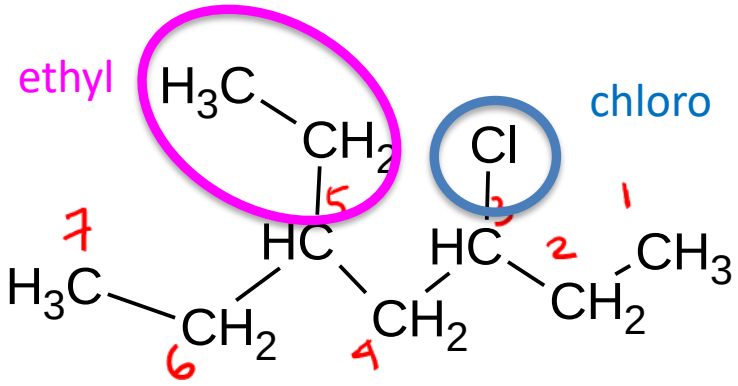


heptane

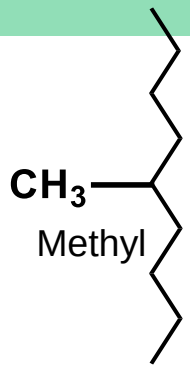
IUPAC Nomenclature : For complicated organic compounds

For **alkanes** and their derivatives

3. Identify substituents (e.g. methyl, ethyl, bromo, chloro). If more than one substituent of the same kind is present, use the prefixes "di" for two, "tri" for three, "tetra" for four….



Naming Alkyl Substituents: most common



$CH_3—H$
Methane

CH_3
Methyl

$CH_3CH_2—H$
Ethane

$CH_3CH_2—$
Ethyl

$CH_3CH_2CH_2—H$
Propane

$CH_3CH_2CH_2—$
Propyl

$CH_3CH_2CH_2CH_2—H$
Butane

$CH_3CH_2CH_2CH_2—$
Butyl

Halides

Cl = chloro

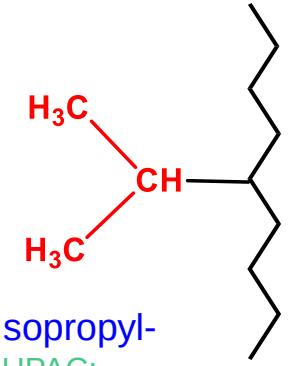
Br = bromo

I = iodo

F = fluoro

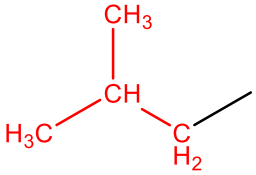
Naming Alkyl Substituents: common names FYI!

How most chemists name them (**this is not the current IUPAC system**)



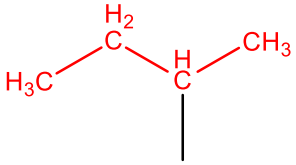
Isopropyl-

IUPAC:
1-methylethyl



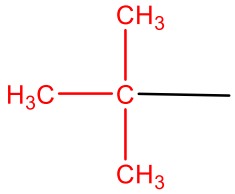
Isobutyl-

IUPAC:
2-methylpropyl



sec-butyl-
or
s-butyl

IUPAC:
butan-2-yl



tert-butyl-
or
t-butyl

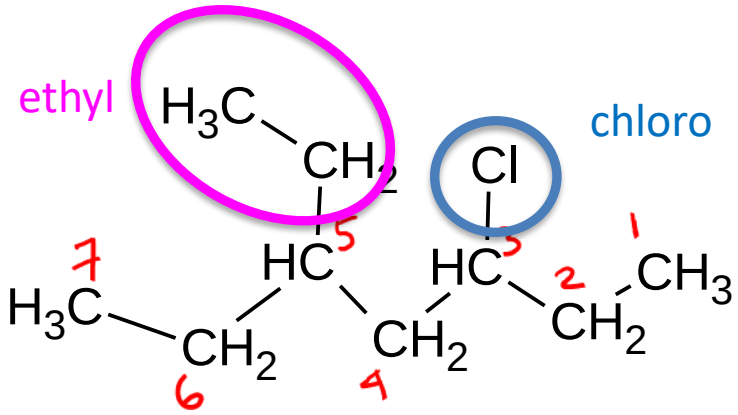
IUPAC: tert-butyl

IUPAC Nomenclature: For complicated organic compounds
need to memorize these rules (or practice practice practice!)

For alkanes and their derivatives

4. Locate the numbered carbon to which the substituents are attached.

5. Put substituents in alphabetical order (multiplier prefixes like "di", "tri" do not count).



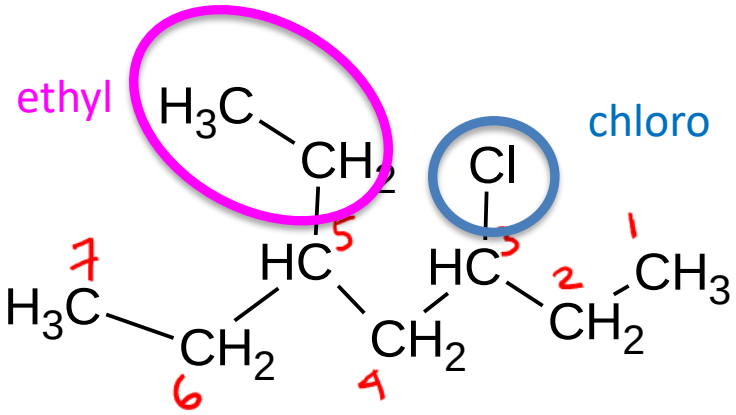
3-chloro
5-ethyl
heptane

note: it is NOT
3-ethyl
5-chloro
heptane (if the order of how you number the chain is tied on both side; you want the lowest number on the earliest letter in the alphabet)

IUPAC Nomenclature: For complicated organic compounds
need to memorize these rules (or practice practice practice!)

For alkanes and their derivatives

6. Separate numbers from letters by a dash and write the <u>whole name as one word</u> with the base name at the end.



3-chloro
5-ethyl
heptane

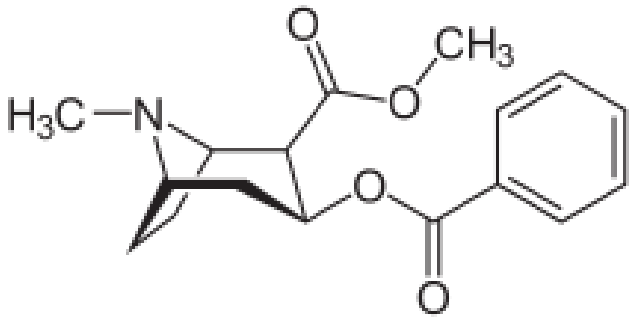
FINAL ANSWER: 3-chloro-5-ethylheptane

IUPAC Nomenclature : For complicated organic compounds

INGREDIENTS: WATER (75%), **SUGARS (12%)** (GLUCOSE (48%), FRUCTOSE (40%), SUCROSE (2%), MALTOSE (<1%)), STARCH (5%), FIBRE E460 (3%), **AMINO ACIDS (<1%)** (GLUTAMIC ACID (19%), ASPARTIC ACID (16%), HISTIDINE (11%), LEUCINE (7%), LYSINE (5%), PHENYLALANINE (4%), ARGININE (4%), VALINE (4%), ALANINE (4%), SERINE (4%), GLYCINE (3%), THREONINE (3%), ISOLEUCINE (3%), PROLINE (3%), TRYPTOPHAN (1%), CYSTINE (1%), TYROSINE (1%), METHIONINE (1%)), **FATTY ACIDS (1%)** (PALMITIC ACID (30%), OMEGA-6 FATTY ACID: LINOLEIC ACID (14%), OMEGA-3 FATTY ACID: LINOLENIC ACID (8%), OLEIC ACID (7%), PALMITOLEIC ACID (3%), STEARIC ACID (2%), LAURIC ACID (1%), MYRISTIC ACID (1%), CAPRIC ACID (<1%)), ASH (<1%), PHYTOSTEROLS, E515, OXALIC ACID, E300, E306 (TOCOPHEROL), PHYLLOQUINONE, THIAMIN, **COLOURS** (YELLOW-ORANGE E101 (RIBOFLAVIN), YELLOW-BROWN E160a), **FLAVOURS** (3-METHYLBUT-1-YL ETHANOATE, 2-METHYLBUTYL ETHANOATE, 2-METHYLPROPAN-1-OL, 3-METHYLBUTYL-1-OL, 2-HYDROXY-3-METHYLETHYL BUTANOATE, 3-METHYLBUTANAL, ETHYL HEXANOATE, ETHYL BUTANOATE, PENTYL ACETATE), 1510, NATURAL RIPENING AGENT (ETHENE GAS).

IUPAC Nomenclature : For complicated organic compounds

methyl (1*R*,2*R*,3*S*,5*S*)-3-benzoyloxy-8-methyl-8-azabicyclo[3.2.1]octane-2-carboxylate



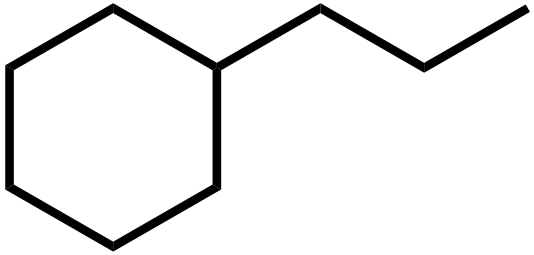
cocaine

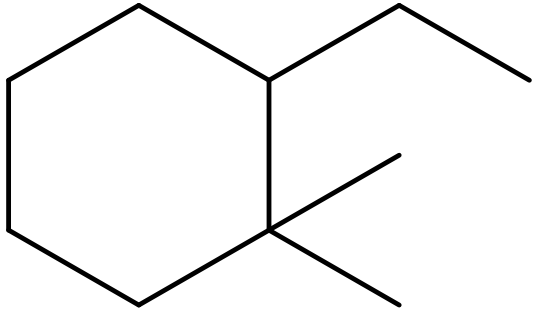
IUPAC Nomenclature : For complicated organic compounds

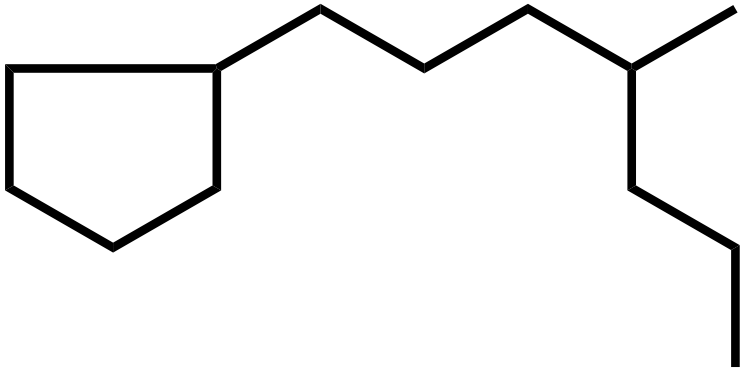
For cycloalkanes and their derivatives

1. Determine the number of carbon atoms in the ring.
2. Add the prefix cyclo- to the name of the corresponding alkane.
3. If only one substituent: not necessary to designate number.
4. If two substituents: assign C1 to substituent first in the alphabet and number in the direction that gives next substituent the lowest number.
5. If three substituents or more: begin at the substituent that leads to the lowest overall (total) numbering of the other substituents.
6. When the ring is attached to an alkyl chain, the ring almost always gets priority/based name. (Note this is different than in the past). Even if the alkyl side chain is longer than the ring, even if the chain has bromo groups, double bonds, triple bonds; the ring gets the base name. This changes if the side chain is an alcohol, amine (etc) but we will NOT cover that.

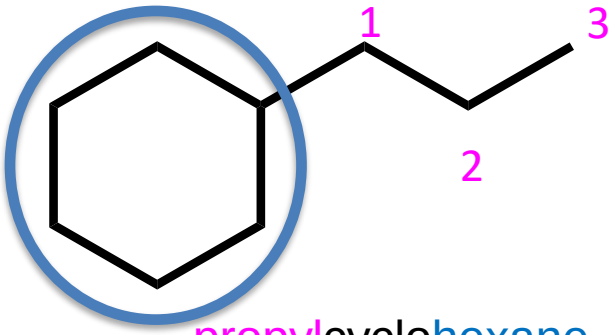
IUPAC Nomenclature : For complicated organic compounds



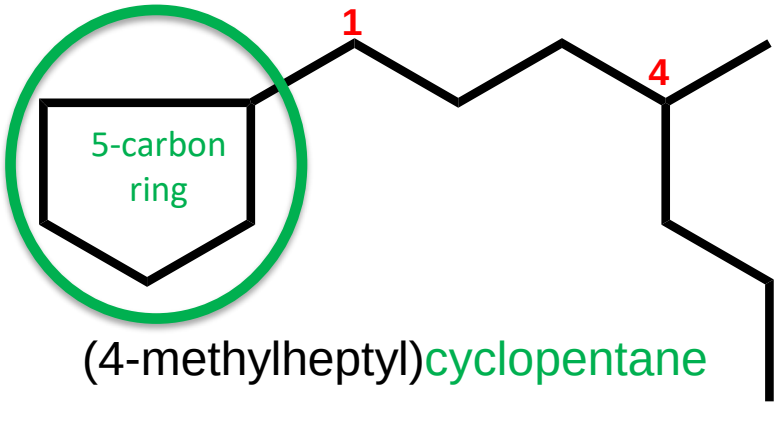




IUPAC Nomenclature : For complicated organic compounds

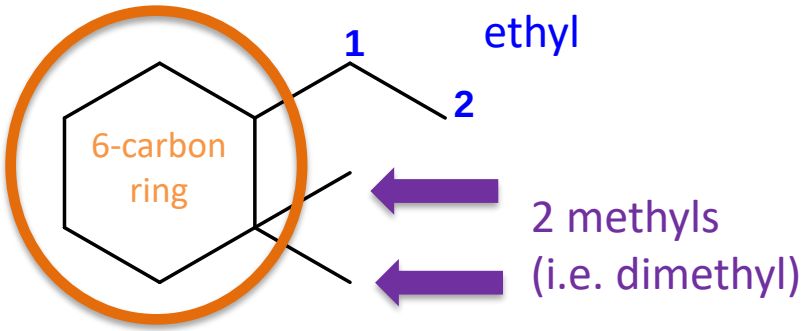


propylcyclohexane



(4-methylheptyl)cyclopentane

Even through the heptane chain is longer than the cycloalkane chain, the cyclo still gets the base name.



2-ethyl-1,1-dimethylcyclohexane

2 + 1 + 1 = 4

This compound will not be called

1-ethyl,2-2,dimethylcyclohexane

1 + 2 + 2 = 5

If three substituents or more: begin at the substituent that leads to the lowest overall (total) numbering of the other substituents.

IUPAC Nomenclature: Alkenes/Cycloalkenes

For alkenes, cycloalkenes and their derivatives

CYCLOALKENES:

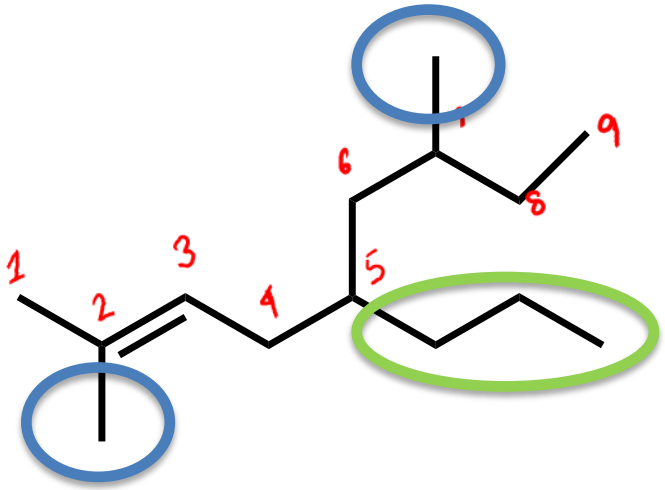
1. Number the carbons of the double bond as C1 and C2.

ALKENES:

1. Select the longest continuous chain of carbon atoms that contains both carbons of the double bond for the basic name (end with –ene).
2. Number the carbons in the chain from the end nearest the first carbon of the double bond. The first carbon of the double bond is also the numbering of the double bond
3. Substituent numbering and identification – same as alkanes.

NOTE: the double bond takes priority (compared to other substituents) regardless of “lowest total numbers”

IUPAC Nomenclature



1) 9 carbon chain with a double bond = Nonene
2) Where is the double bond starting? 2
   Non-2-ene

3)
-Two methyl groups (i.e. dimethyl)
-one propyl group

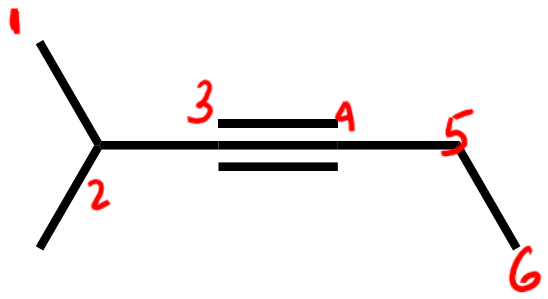
2,7-dimethyl-5-propylnon-2-ene

IUPAC Nomenclature: Alkynes

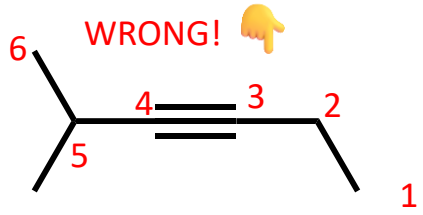
For alkynes and their derivatives

1. Select the longest continuous chain of carbon atoms that contains both carbons of the triple bond for the basic name. (Name ends with –yne)
2. Number the carbons in the chain from the end nearest the first carbon of the triple bond. The first carbon of the triple bond is also the numbering of the triple bond
3. Substituent numbering and identification – same as alkanes.

IUPAC Nomenclature: Alkynes

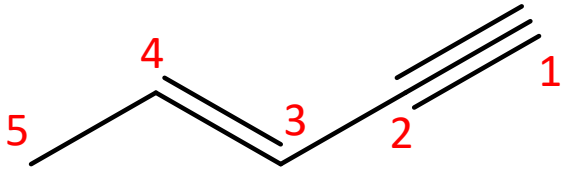


2-methylhex-3-yne



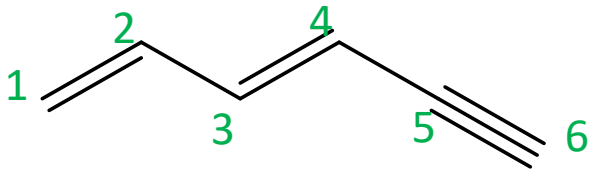
Could label chain either way to give **3-yne (the priority)**; so in this case SINCE the triple bond is a tie either way, you must go with the direction that gives the lowest total numbers! IUPAC left NOTHING up to choice/ambiguity!!!
i.e. 2-methylhex-3-yne
BUT NOT: 5-methylhex-3-yne

IUPAC Nomenclature: Alkynes + alkenes: important rule!



3-penten-1-yne

When both double and triple bonds are present, number the chain so that you get the lowest possible numbers even though this may at times give "-yne" a lower number than "-ene" like it is here.



1,3-hexadien-5-yne

HOWEVER, when there is a choice in numbering (because it's a tie in total numbers either way), then double bonds (-ene) are given the lowest numbers. This is because we always break a numbering tie with alphabetical order. In this case, – ene before -yne

Summary for nomenclature of complex chains

1) Alkene/alkynes should be in the main chain and thus takes the "lowest number" priority (i.e. closer to #1 on the chain)

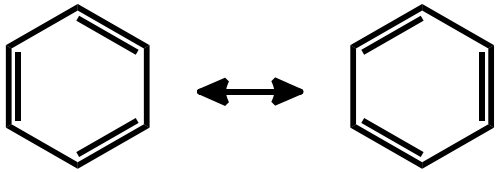
2) Then, after that, try to keep the numbers as low as possible for the rest of the substituents

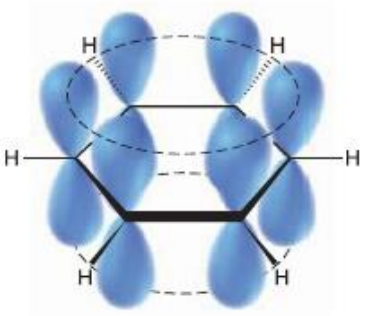
3) If there is a "tie" in the substituents, then go with alphabetical order

Note: rule #1 has been slightly updated by IUPAC but is not reflected in the textbook yet. So we will keep this rule as is for simplicity in this course!

Aromatic Compounds

AROMATICS (BENZENE RINGS):



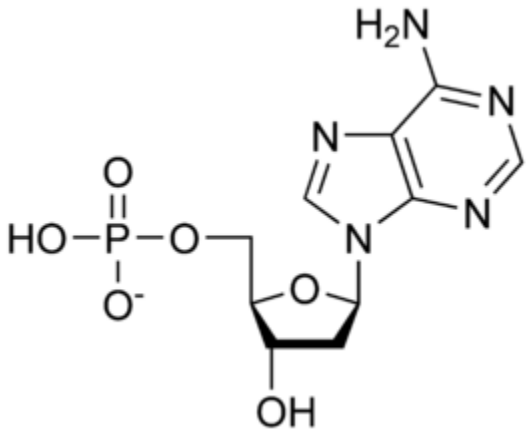


Planar (all ring carbon atoms sp^2)

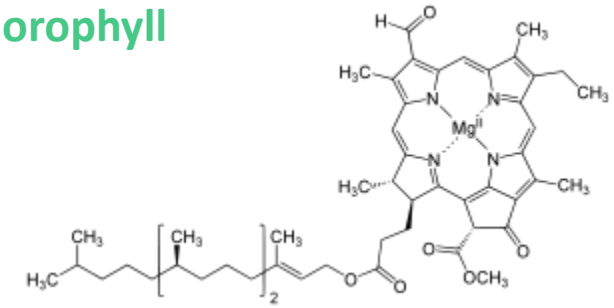
Organic compounds that are not aromatic are classified as aliphatic compounds—they might be cyclic, but only **aromatic** rings have special stability (low reactivity).

Aromatic Compounds – in nature (because they are stable!)

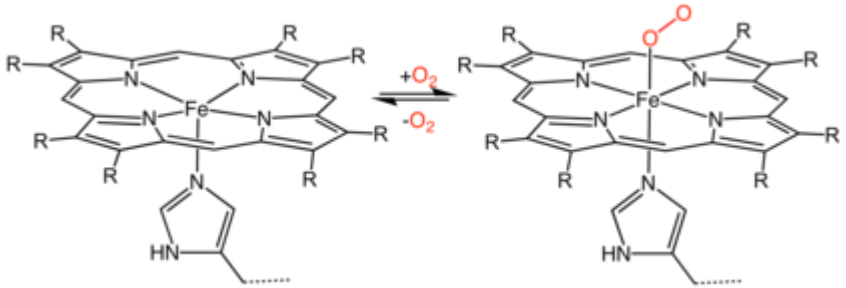
All the nucleotides!!!



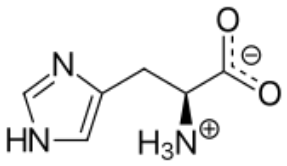
Chlorophyll

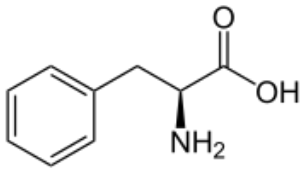


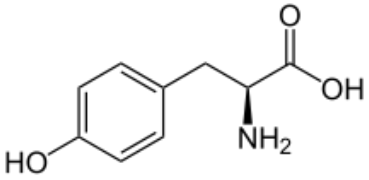
Heme

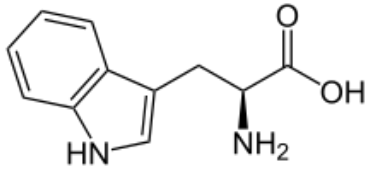


Several amino acids



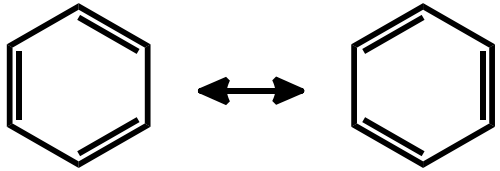






Aromatic Compounds

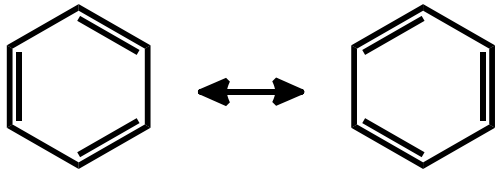
AROMATICS (BENZENE RINGS):

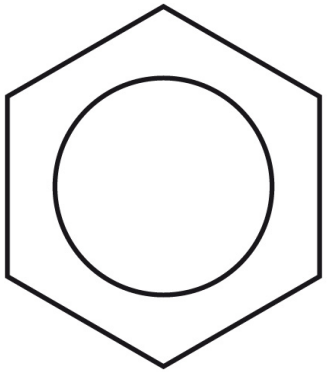


Benzene

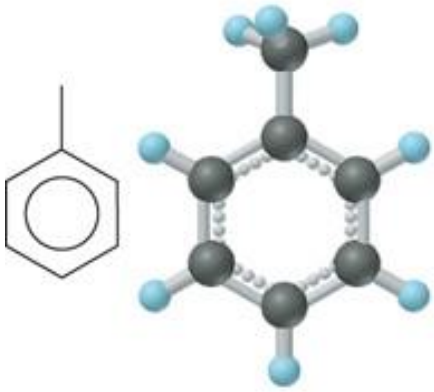
Aromatic Compounds

AROMATICS (BENZENE RINGS):





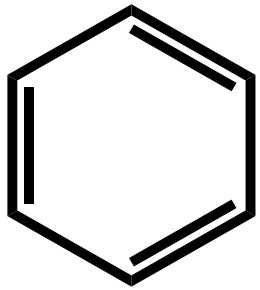
Benzene



Methylbenzene
(toluene)

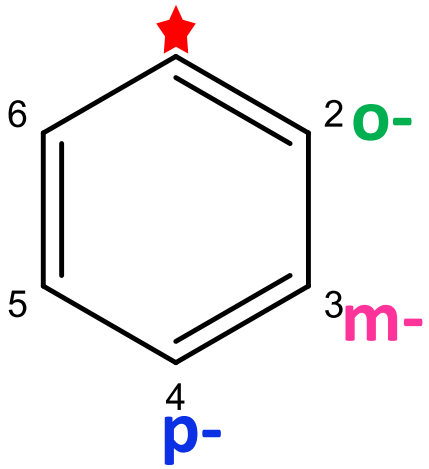
Aromatic Compounds

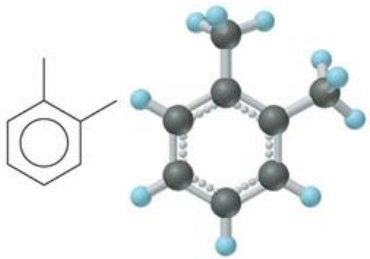
AROMATICS (BENZENE RINGS):



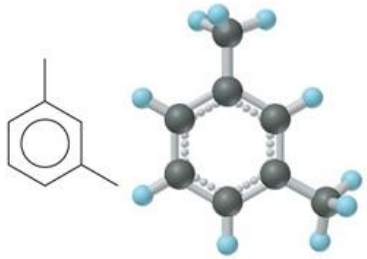
Aromatic Compounds

Older, yet **widely** used nomenclature, starts with substituent in location 1 of a benzene ring, and locations 2, 3, and 4 are denoted **ortho** (abbreviated o-), **meta**- (m-), and **para**- (p-).

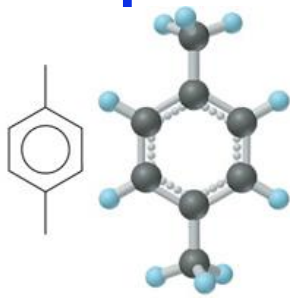




the groups are ortho to each other

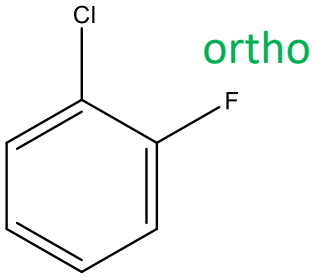


groups are meta to each other

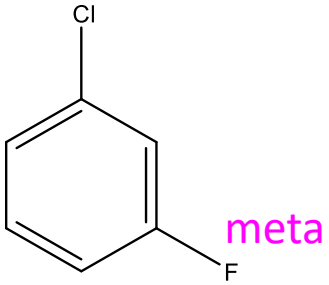


groups are para to each other

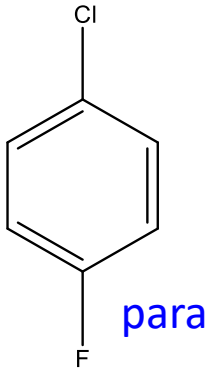
Another example:



1,2-chlorofluorobenzene



1,3-chlorofluorobenzene



1,4-chlorofluorobenzene

Congrats on surviving nomenclature!!!!

Funny “common” names

http://www.chm.bris.ac.uk/sillymolecules/sillymols.htm