Today

Organic

Carbon Chemistry

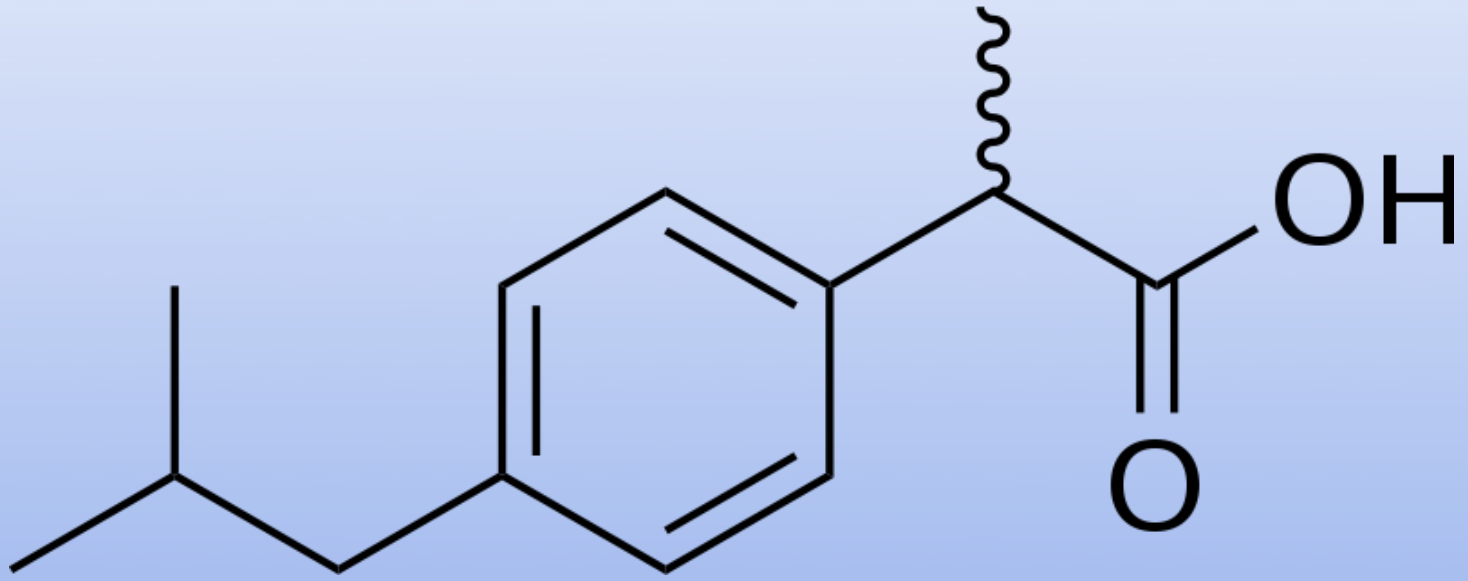
Organic

You know more than you think already

What you will need
Lewis dot, VSEPR
VB, hybrid orbitals, MO
electronegativity
intermolecular forces

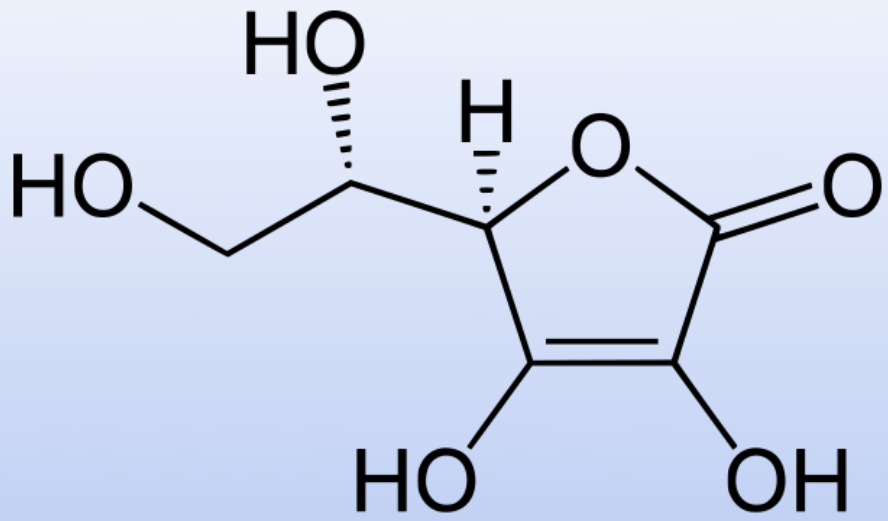
Two hurdles we will deal with

Understanding structures
Nomenclature



Ibuprofen

RS)-2-(4-(2-methylpropyl)phenyl)propanoic acid



vitamin C

L-ascorbic acid

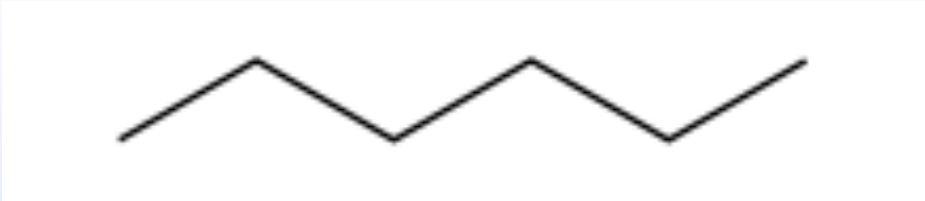
R)-3,4-dihydroxy-5-((*S*)- 1,2-dihydroxyethyl)furan-2(5*H*)-one

First Structures

Let's look at a simple molecule

butane C_4H_{10}

How many carbon atoms does this molecule have?



A. 0

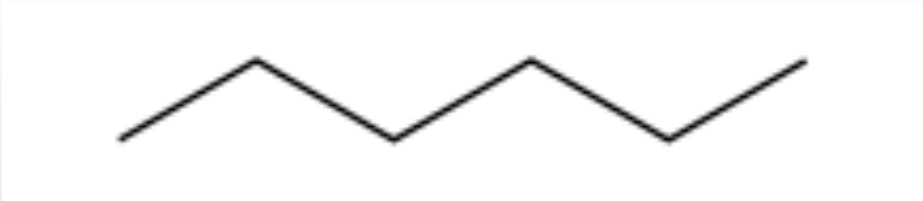
B. 4

C. 5

D. 6

E. 7

How many hyrdogen atoms does this molecule have?



A. 6

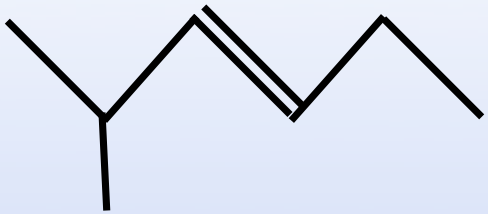
B. 10

C. 12

D. 14

E. 16

How many carbons and hydrogens in the following?



A. 6 C, 14 H

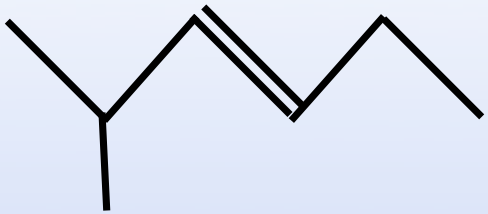
B. 6 C, 15 H

C. 6 C, 16 H

D. 7 C, 15 H

E. 7 C, 14 H

How many carbons and hydrogens in the following?



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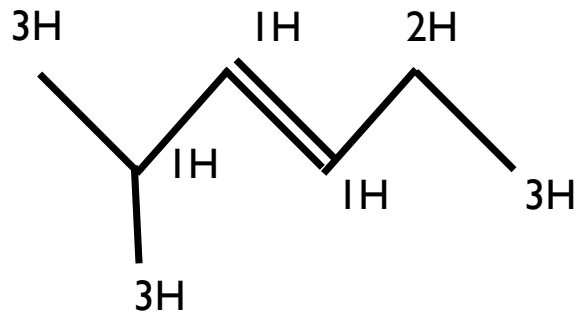
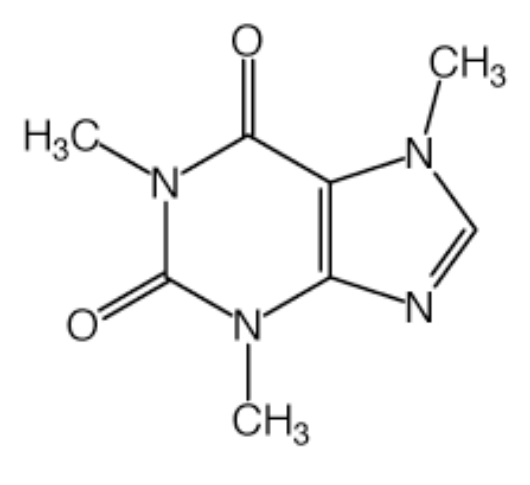




this is the structure for caffeine

how many hydrogens are not shown?

A. 0

B. 1

C. 2

D. 3

E. 4

Step 1

Nomenclature

prefix parent suffix

parent is the name of the longest carbon chain. Each length has a given name

1 carbon methane
2 carbons ethane
5 carbons pentane

Step 1

Nomenclature

prefix parent suffix

suffix is the name of the "functional group"

-ol alcohol
-one ketone
-ane alkane

Step 1

Nomenclature

prefix parent suffix

prefix is the name of any substituent groups typically a carbon chain(sidechains)

1 carbon methyl
2 carbons ethyl
5 carbons pentyl

Names for parent groups

First lets look at alkanes
(essentially no functional group)

All single bonds

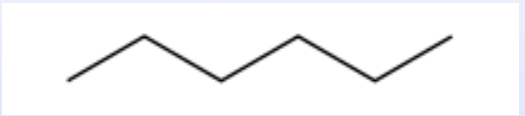
suffix is ane

methane butane 5-methyloctane

Number of carbon atoms	Formula	Name of alkane	Name of alkyl group	Formula
1	CH_4	methane	methyl	CH_3-
2	CH_3CH_3	ethane	ethyl	CH_3CH_2-
3	$CH_3CH_2CH_3$	propane	propyl	$CH_3CH_2CH_2-$
4	$CH_3(CH_2)_2CH_3$	butane	butyl	$CH_3(CH_2)_2CH_2-$
5	$CH_3(CH_2)_3CH_3$	pentane	pentyl	$CH_3(CH_2)_3CH_2-$
6	$CH_3(CH_2)_4CH_3$	hexane	hexyl	$CH_3(CH_2)_4CH_2-$
7	$CH_3(CH_2)_5CH_3$	heptane	heptyl	$CH_3(CH_2)_5CH_2-$
8	$CH_3(CH_2)_6CH_3$	octane	octyl	$CH_3(CH_2)_6CH_2-$
9	$CH_3(CH_2)_7CH_3$	nonane	nonyl	$CH_3(CH_2)_7CH_2-$
10	$CH_3(CH_2)_8CH_3$	decane	decyl	$CH_3(CH_2)_8CH_2-$
11	$CH_3(CH_2)_9CH_3$	undecane	undecyl	$CH_3(CH_2)_9CH_2-$
12	$CH_3(CH_2)_{10}CH_3$	dodecane	dodecyl	$CH_3(CH_2)_{10}CH_2-$

The following compound is

$CH_3CH_2CH_2CH_2CH_2CH_3$



A. butane

B. isobutane

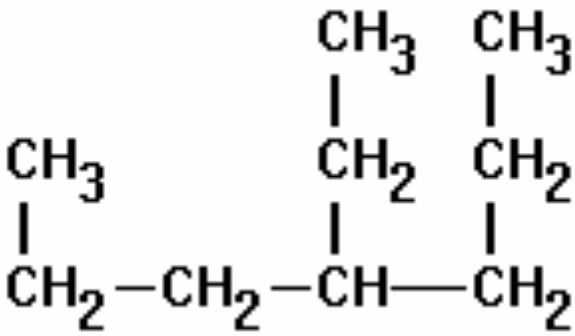
C. pentane

D. hexane

E. heptane

What about sidechains?

The following compound is



A. 3-ethylhexane

B. 3-ethylpropane

C. 4-propylhexane

D. 4-ethylheptane

E. 3-ethylocatne

Which numbers do I use?

longest main chain
lowest possible numbers

The next simplest
add a functional group

C=C Double bond

suffix -ene

C≡C Triple bond

suffix -yne

The following compound is

A. 2-hexene

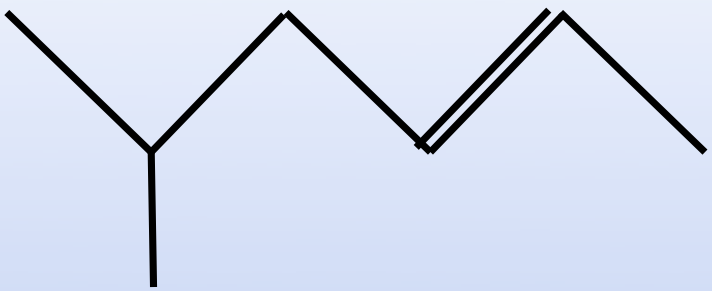
B. 3-hexene

C. 4-heptene

D. 4-hexene

E. 2 methyl, butene

The following compound is

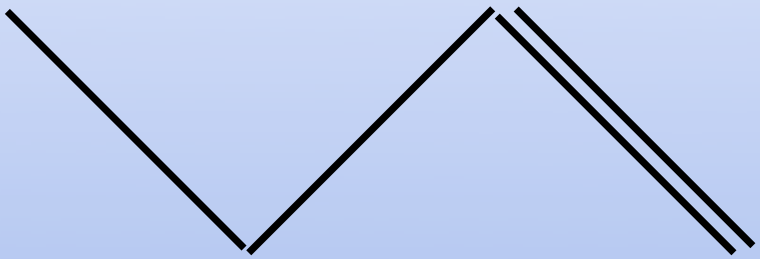


A. 5-methyl 2-hexene

B. 2-methyl 5-hexene

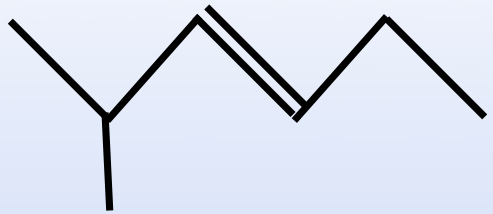
Nomenclature with functional group

Put the number by before the functional group suffix



old system (everyone uses)	official IUPAC name
1 butene	but-1-ene

Name this compound



A. 2-methyl 5-pentene

B. 2-methyl 3-hexene

C. 1,1-dimethyl 2-pentene

D. 5-methyl 3-hexene

E. 5-methyl 4-hexene

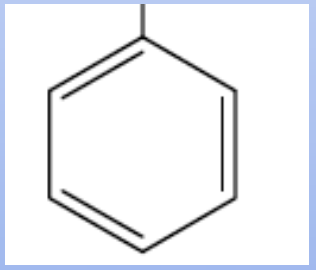
Other side-chains

Halogens
- F Fluoro
- Cl Chloro
- Br Bromo
- I Iodo

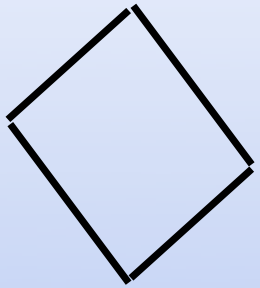
OH group
hydroxy

NH_2 group
amino

Benzene Ring
phenyl



Cyclic Hydrocarbons
the carbon chain connects back to itself

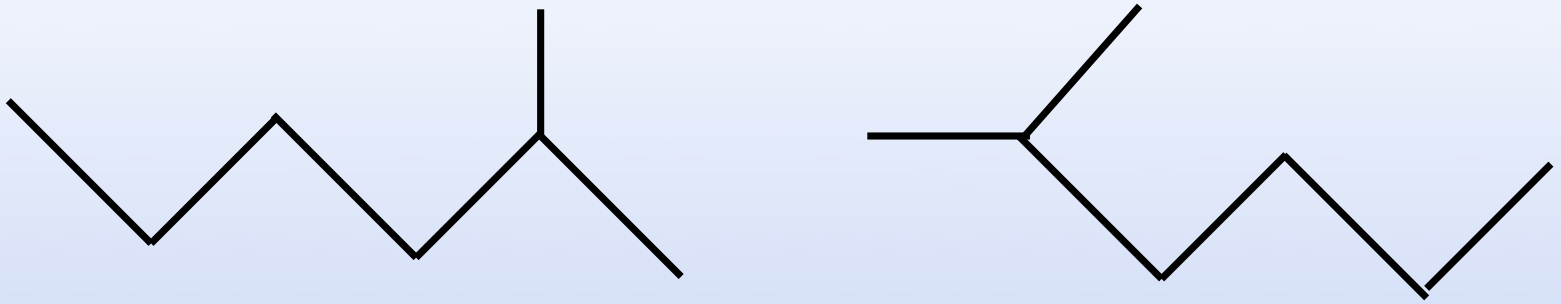


cyclobutane

Structural Isomers

hexane (C_6H_{14})

Are these the same molecule?



A. Yes
B. No

Structural Isomer
(constitutional isomers)

Same atoms and bonds, different bonding pattern

Stereo Isomer
(spatial isomers)

Same bonding pattern, different orientations in space

Structural isomers

n-hexane

2 methyl pentane

Stereoisomers

Diastereomer
(can interconvert)

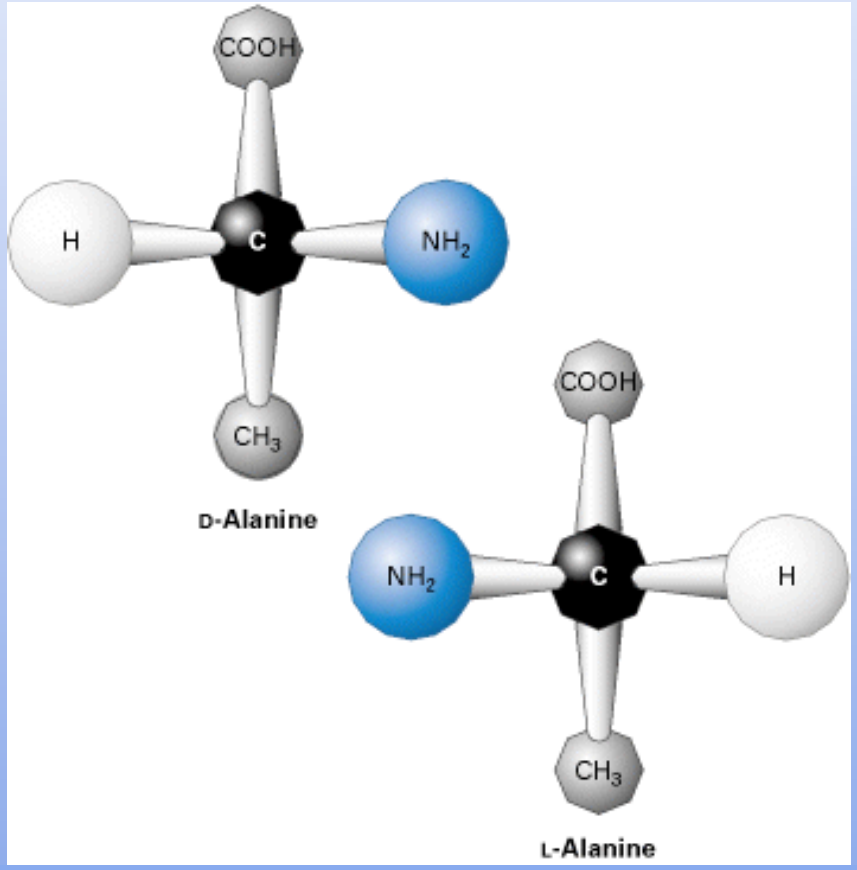
cis dichloro ethene

trans dichloroethene

Stereoisomers

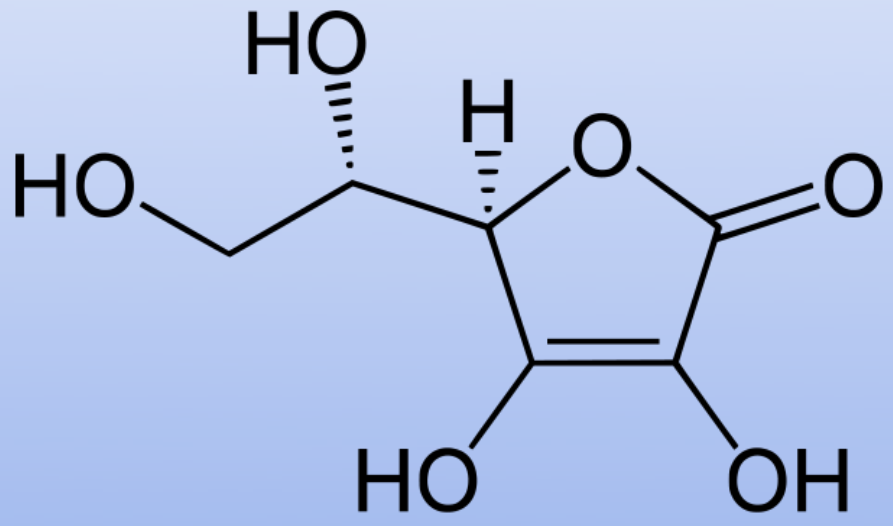
Enantiomers
(chiral molecules)

Molecules cannot be superimposed
(left and right hand versions)



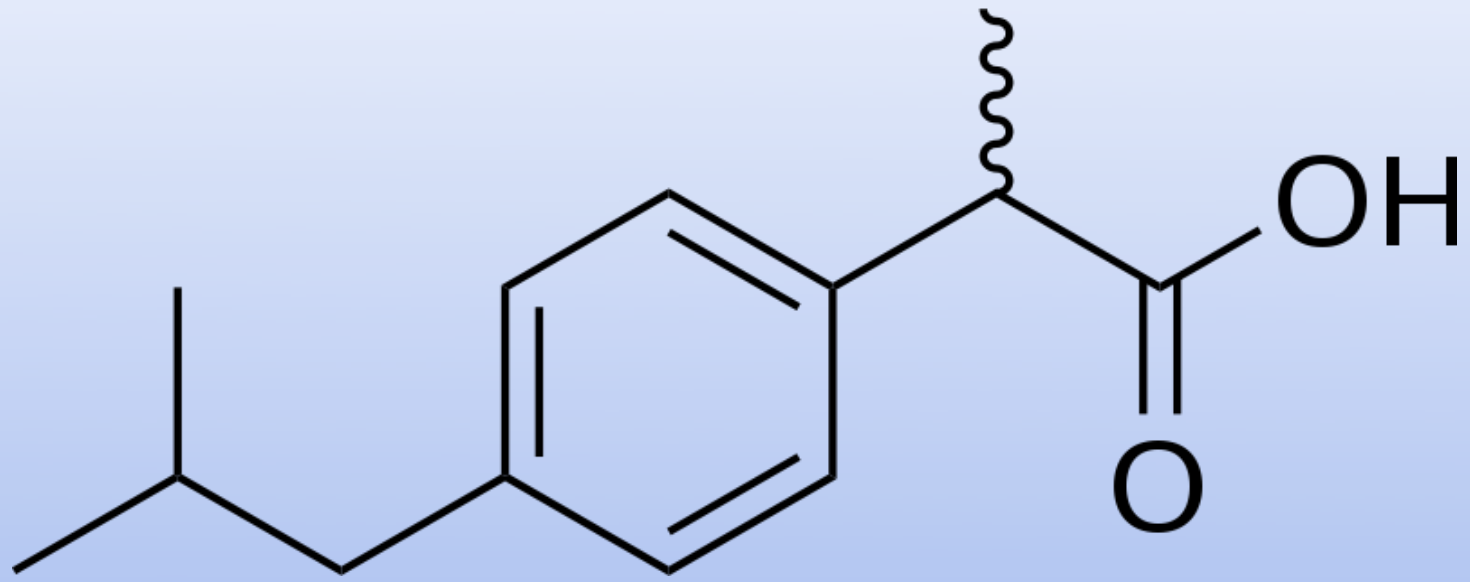
Chiral Center
(place where the chirality arises)

Carbon (or other atom)
with 4 different substituents



vitamin C **L-ascorbic acid**

(*R*)-3,4-dihydroxy-5-((*S*)- 1,2-dihydroxyethyl)furan-2(5*H*)-one

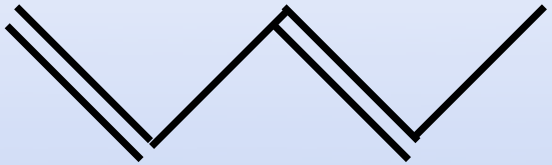


Ibuprofen

RS)-2-(4-(2-methylpropyl)phenyl)propanoic acid

Dienes

Two double bonds



5 carbon chain, parent penta

no side chains

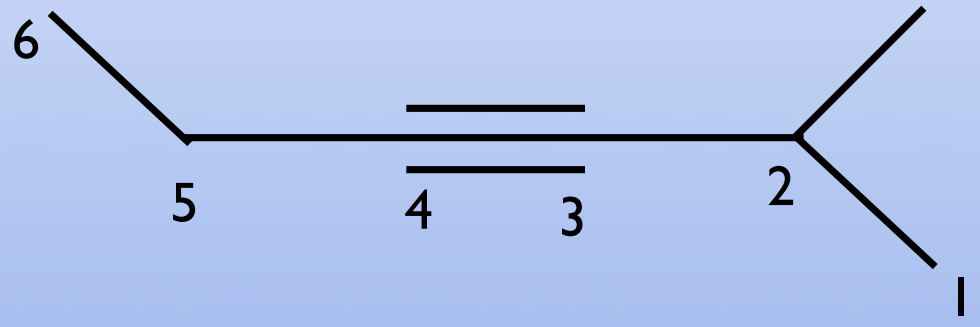
two double bonds diene position 1 and 3

penta-1,3-diene

Alkyne

Carbon Carbon Triple Bond

Suffix -yne



2 methyl hex-3-yne

Other functional groups

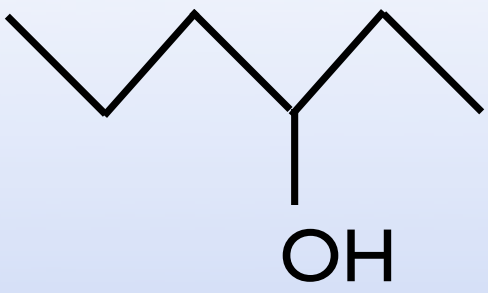
Common Ethanol

R = Generic representation of the rest of the molecule

functional group

-OH group is an alcohol
suffix is -ol

Name this compound



A. heptan-2-ol

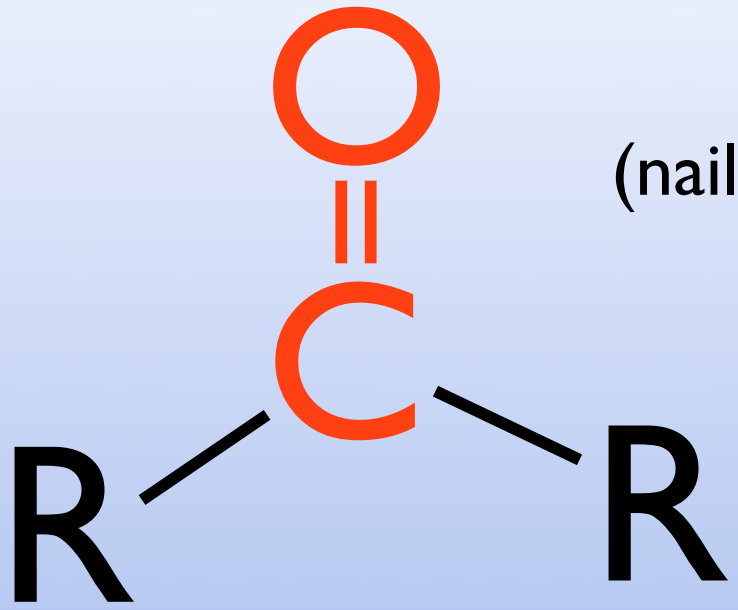
B. hexan-4-ol

C. 2-ethylbutan-1-ol

D. 2-ethylpentan-1-ol

E. hexan-3-ol

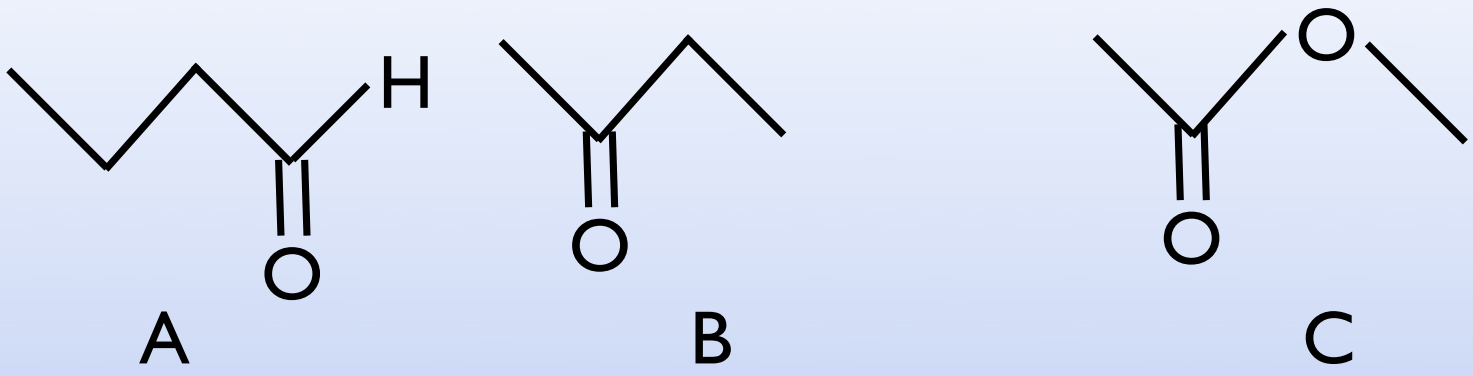
Ketone



Common
Acetone
(nail polish remover)

carbon double bonded to an oxygen
bonded to carbons on either side
suffix is -one

Which of the following is a ketone?



A B C

A. A

B. B

C. C

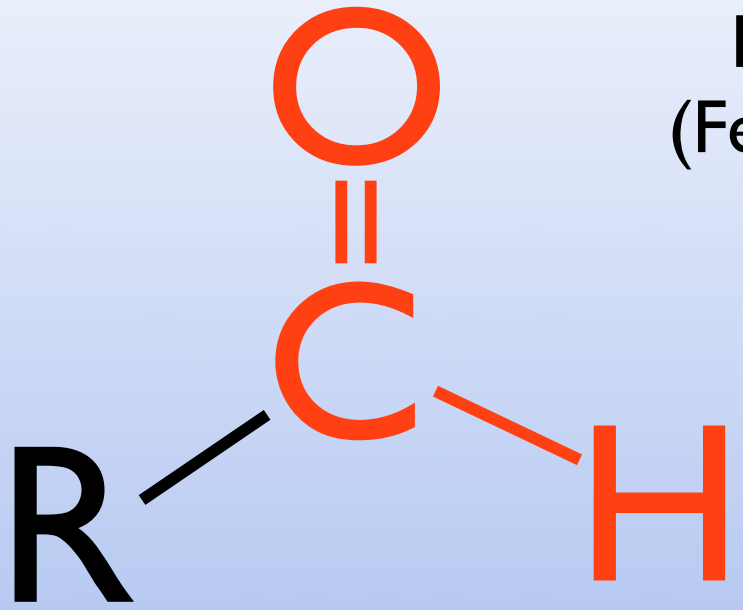
D. A & B

E. all three

butan-3-one

Aldehyde

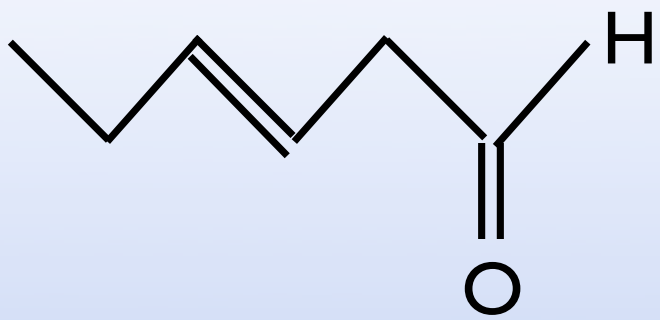
Common
Formaldehyde
(Fetal Pig Storage)



carbon double bonded to an oxygen
bonded to carbon on one side
(like a ketone at the end of a chain)

suffix is -al

Name this compound



A. hex-3-enal

B. hex-3-en-1-al

C. hex-3-en-6-al

D. hex-6-al-3-ene

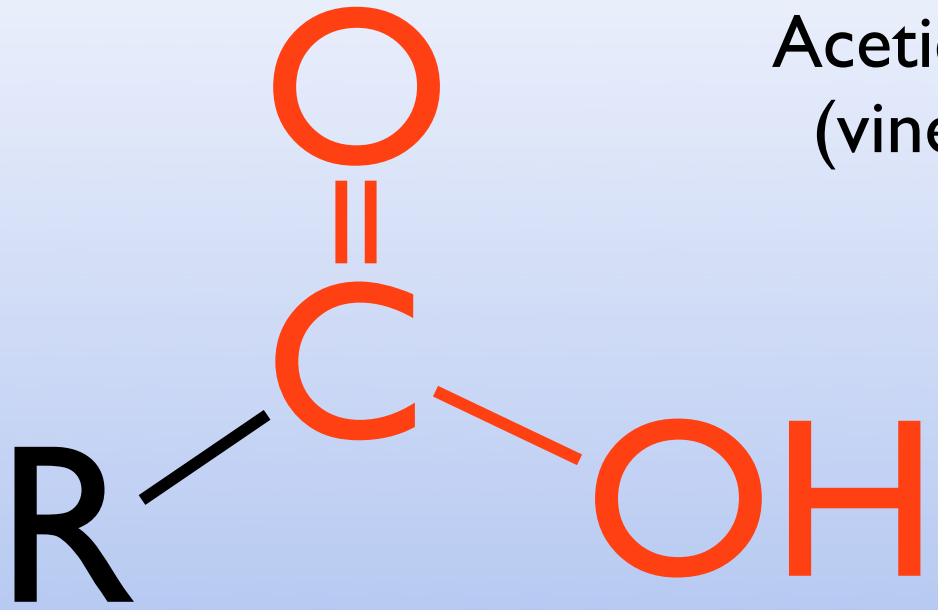
E. hexene6-3-al

No need to number aldehyde its always at the end

H shown to emphasize the functional group

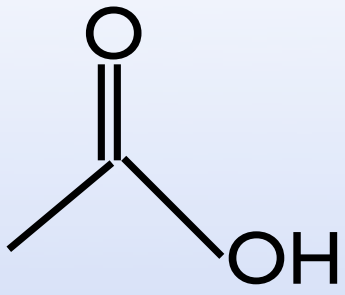
Carboxylic Acid

Common
Acetic Acid
(vinegar)



carbon double bonded to an oxygen
bonded to carbon on one side
OH on the other side
suffix is -oic acid

Name this compound



A. methanoic acid

B. ethanoic acid

C. propanoic acid

D. 3 hydroxy propan-2-one

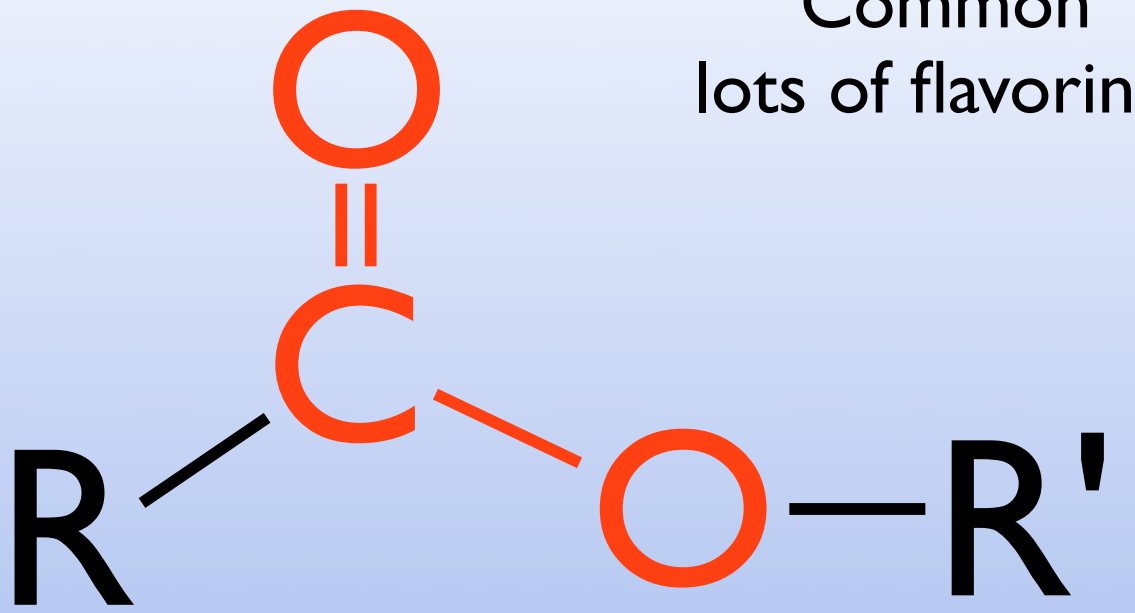
E. propanol

No need to number carboxylic acid its always at the end

this compound is also commonly known as acetic acid

Ester

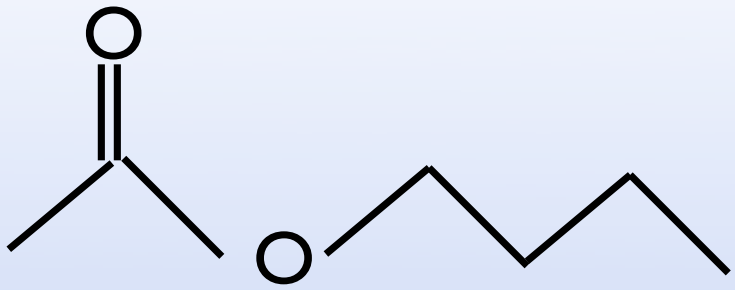
Common
lots of flavorings



carbon double bonded to an oxygen
bonded to carbon on one side
OR on the other side

suffix is -oic acid

Name this compound



A. ethyl butanoate

B. butyl methanoate

C. methyl heptanoate

D. butyl ethanoate

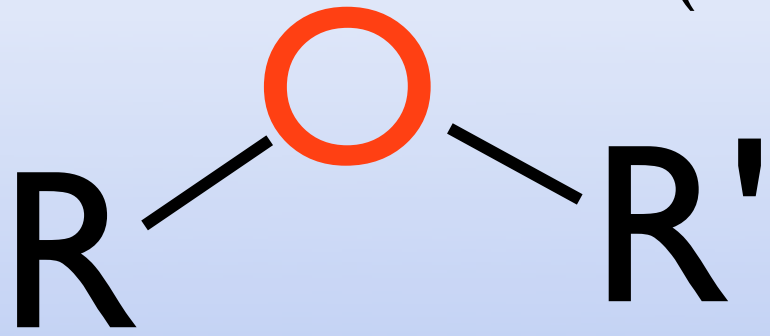
E. pentyl ethanoate

No need to number ester
name the two sides

part with the carboxyl (C=O)
is the parent
other part is like the side chain

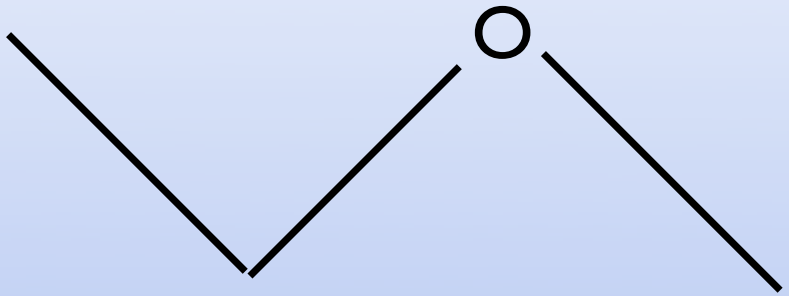
Ether

Diethyl Ether
(knocks you out)



carbon oxygen in the middle of the chain

suffix is -ether



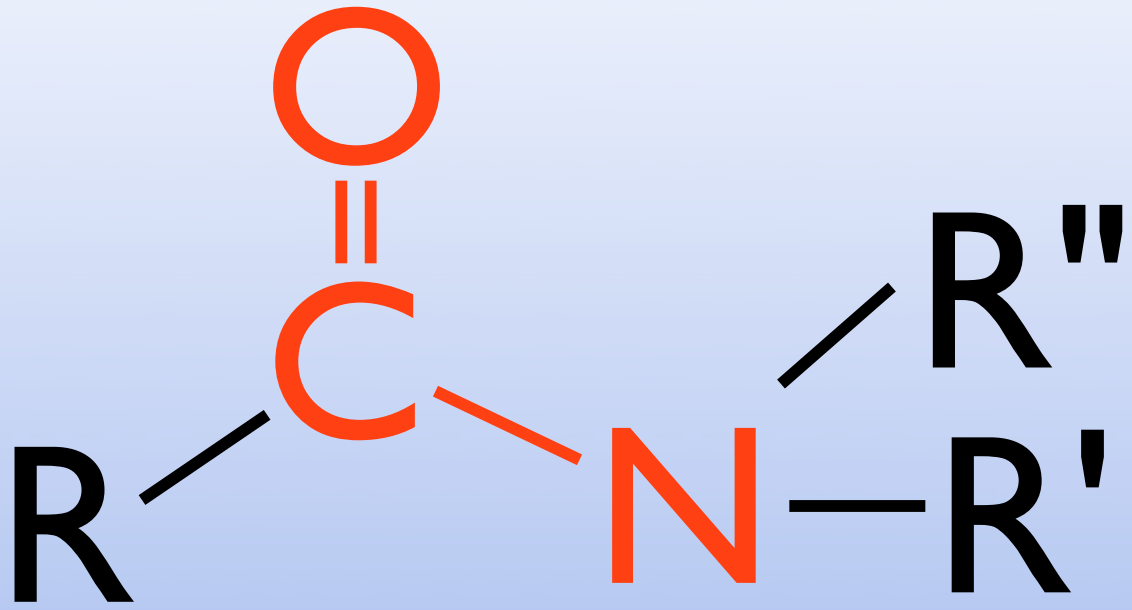
Treat as two "side chains"

methyl ethyl ether

Primary Amine

-NH_2 group is an amine
suffix is -amine

Amide



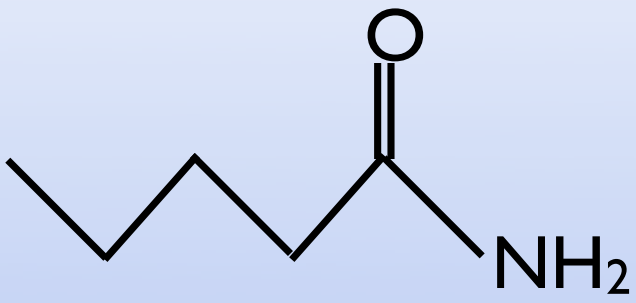
carbon double bonded to an oxygen
bonded to carbon on one side
N on the other side

suffix is -amide

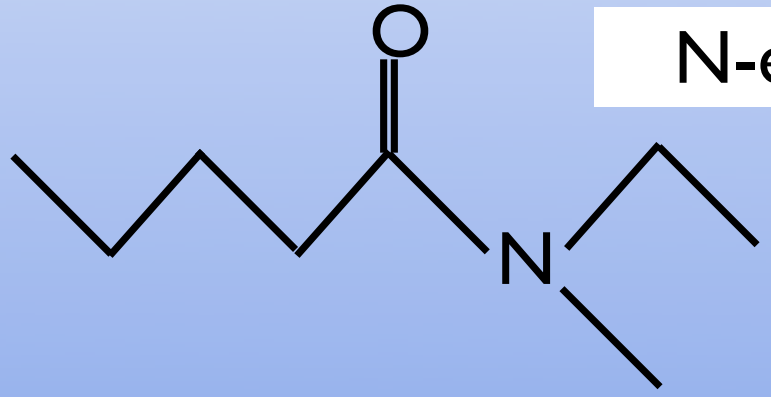
Naming amide

Treat part with C=O as parent

parts on the N as sidechains

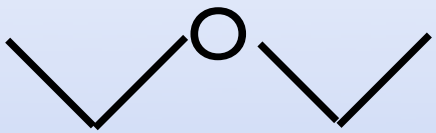


pentanamide

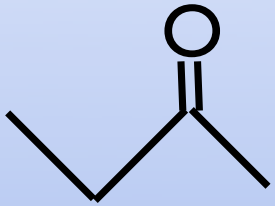


N-ethyl-N-methylpentanamide

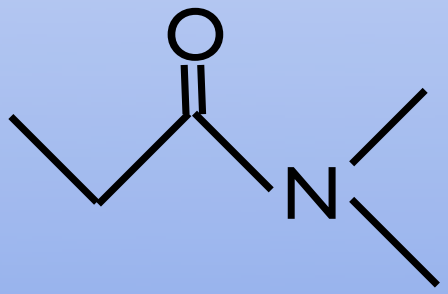
Amine



Ether

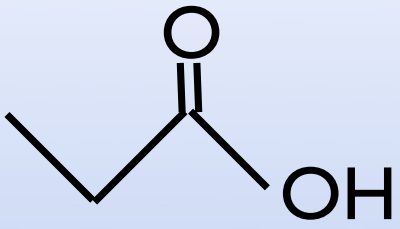


Ketone

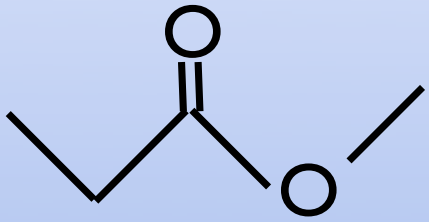


Amide

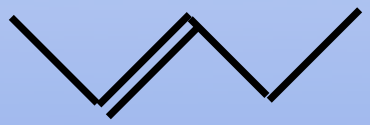
Alcohol



Carboxylic Acid



Ester



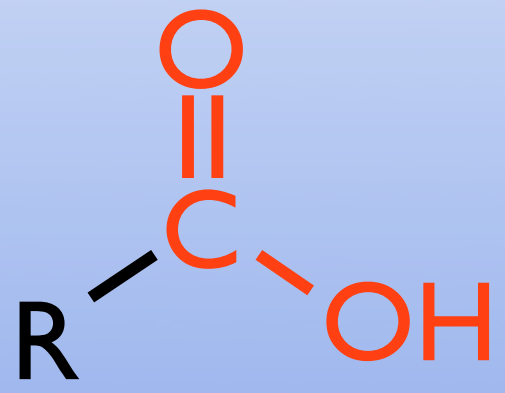
Alkene

Important Reaction for Biochemistry

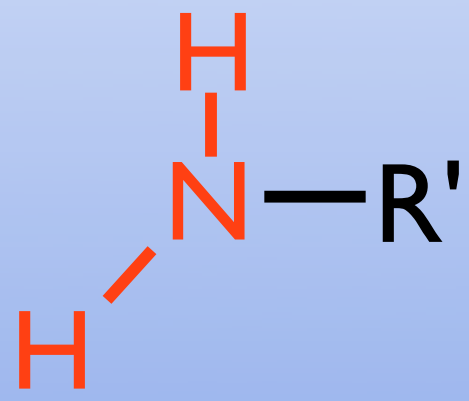
Formation of an Amide

The don't call them functional groups for nothing

Carboxylic Acid

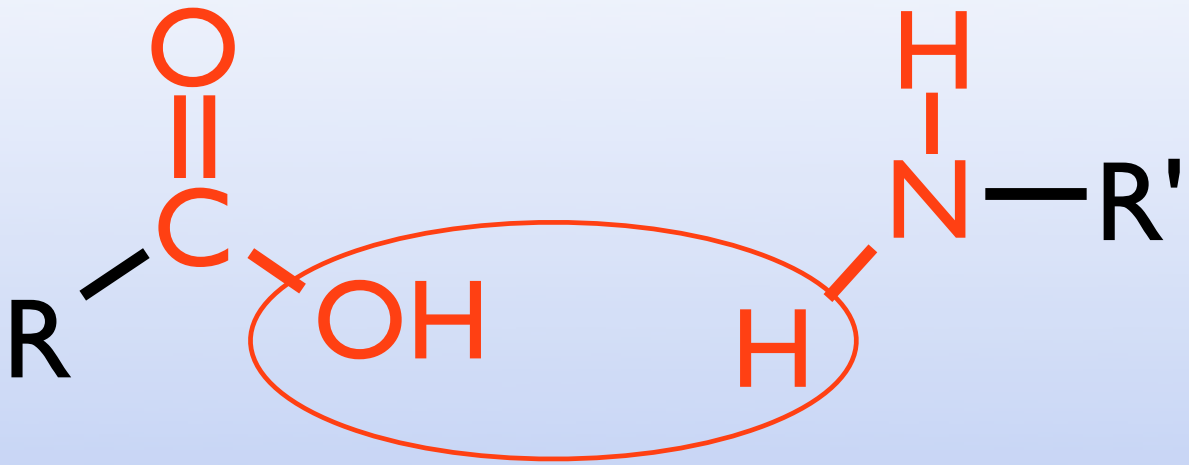


Primary Amine



Carboxylic Acid

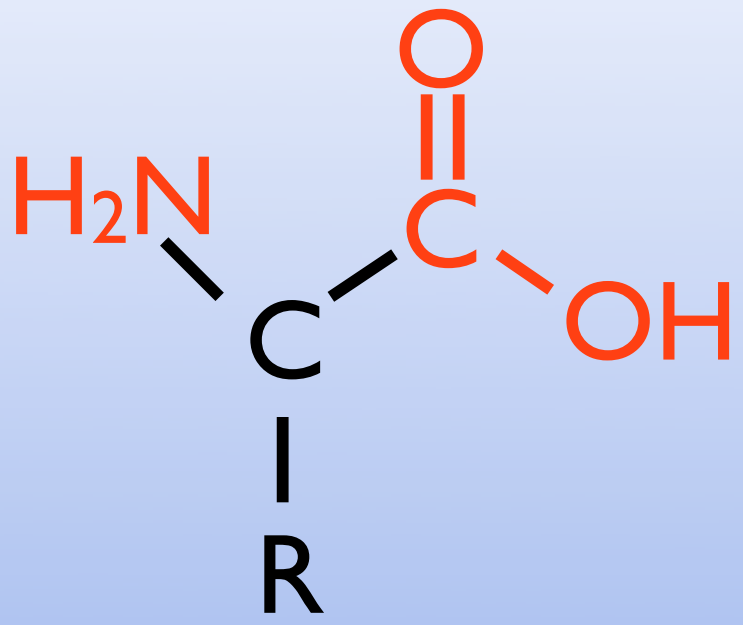
Primary Amine



+ H_2O

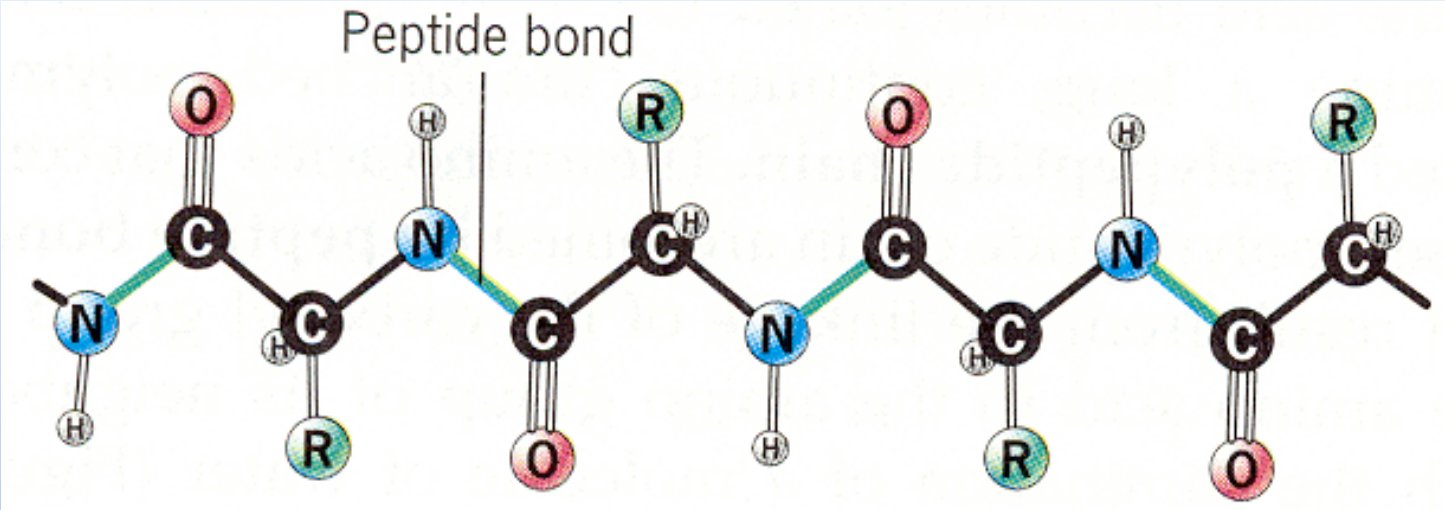
Amide + Water

Amino Acid



Carboxylic End and Amine End
Can react with itself
(or similar molecules) in a chain

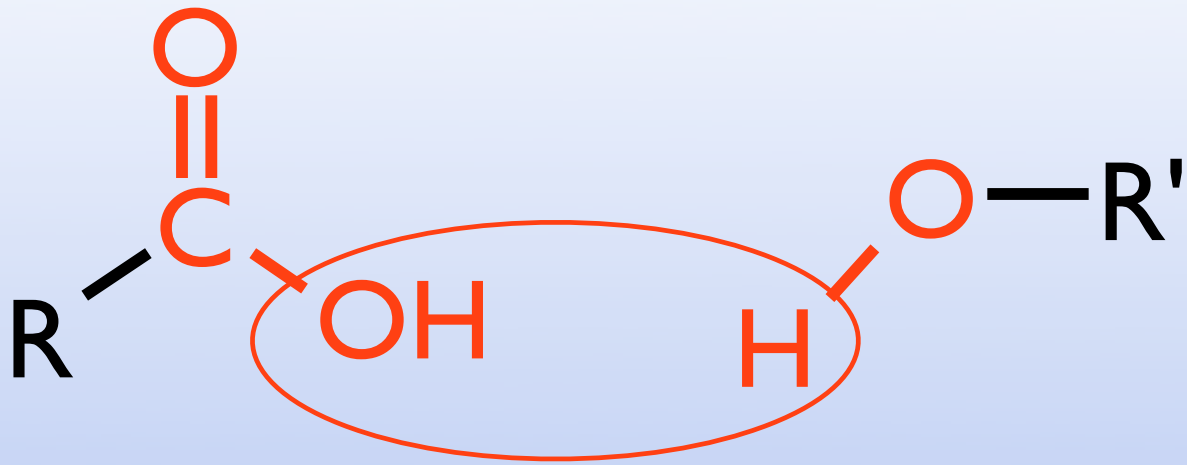
Polypeptide

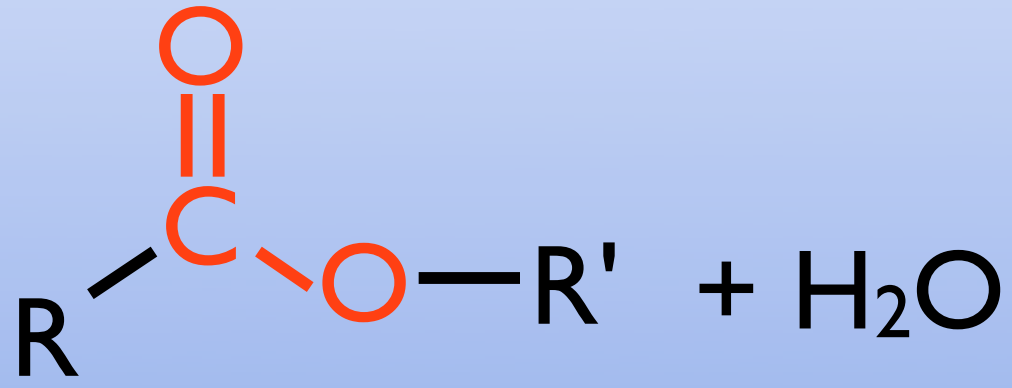


Two distinct ends
N-terminus is an amine
C-terminus is a carboxylic acid

Carboxylic Acid

Alcohol

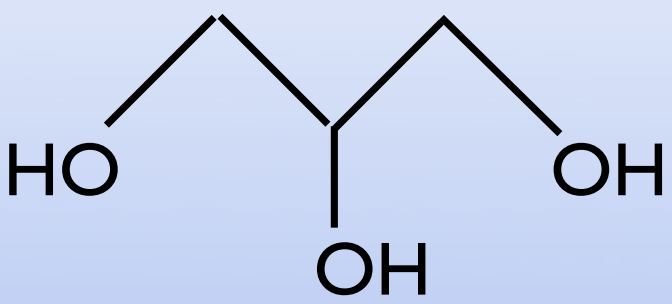




Ester + Water

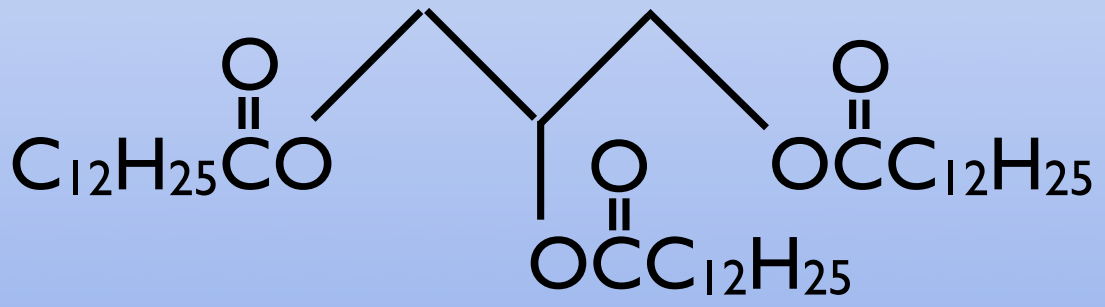
Triglycerides

Gylcerol



Fatty Acid
(carboxylic acid with long chain)

$C_{12}H_{25}COOH$

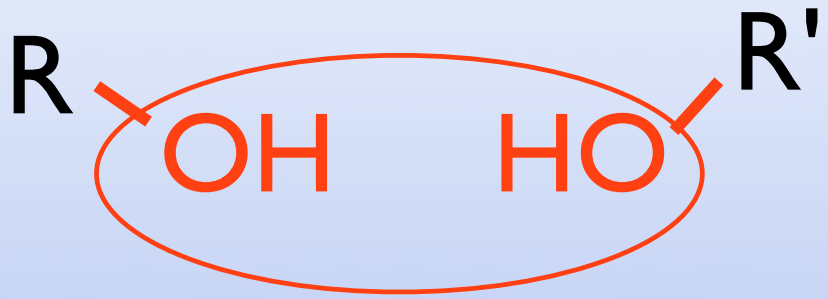


Makes Trigylceride

The three fatty acids can
all be the same or different

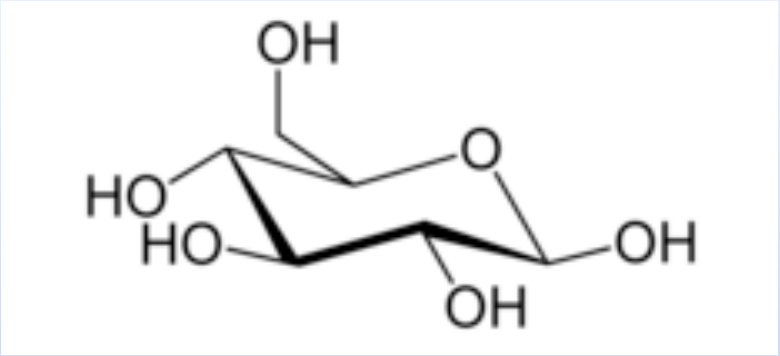
High levels of triglycerides is linked to
build up of plaque in the arteries
= heart disease

Alcohol Alcohol



Ether + Water

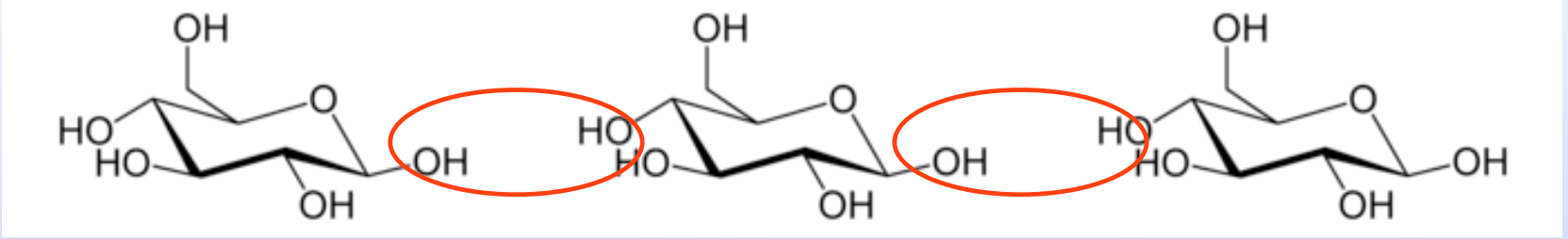
Sugars

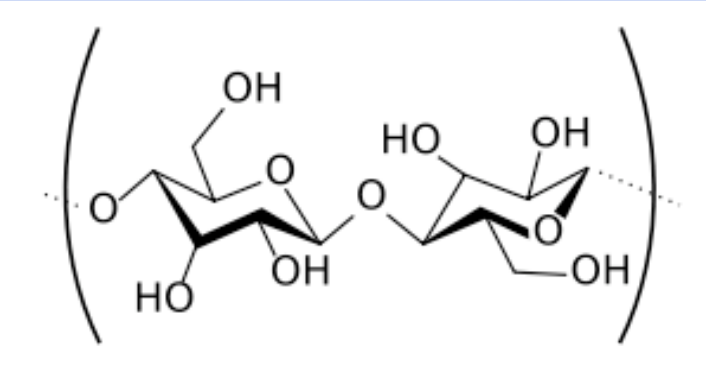


Glucose
(key factor for sugars lots of hydroxyls)

They can react to form chains of sugars
polysaccharide

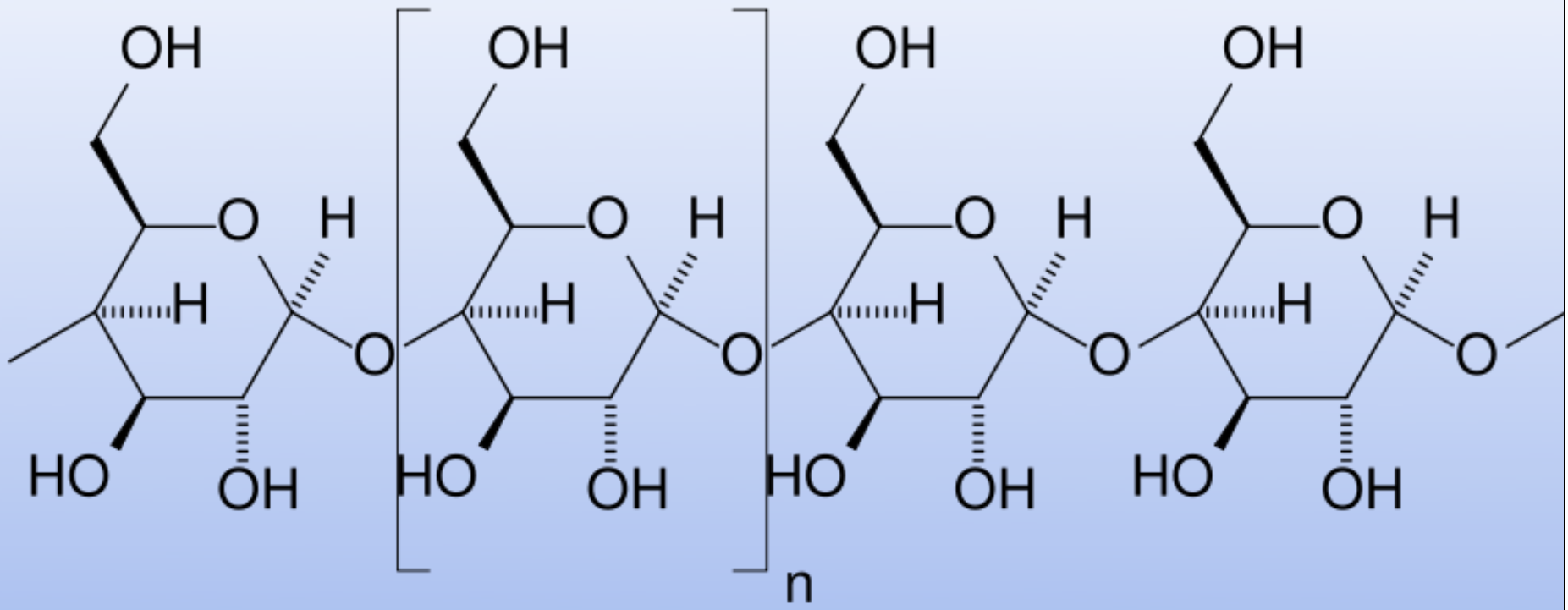
Celluose





Very long ether chain
(pretty much all plant material)

Polysaccharide (Starch)



Sugars, Carbohydrates
monosaccharides (one)
disaccharides (two)
polysaccharides (many)

Condensation Reactions
(two molecules make one + water)

Carboxylic Acid + Amine = Amide + water

Carboxylic Acid + Alcohol = Ester + water

Alcohol + Alcohol = Ether + water