Today

Organic

Carbon Chemistry

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Organic

You know more than you think already

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

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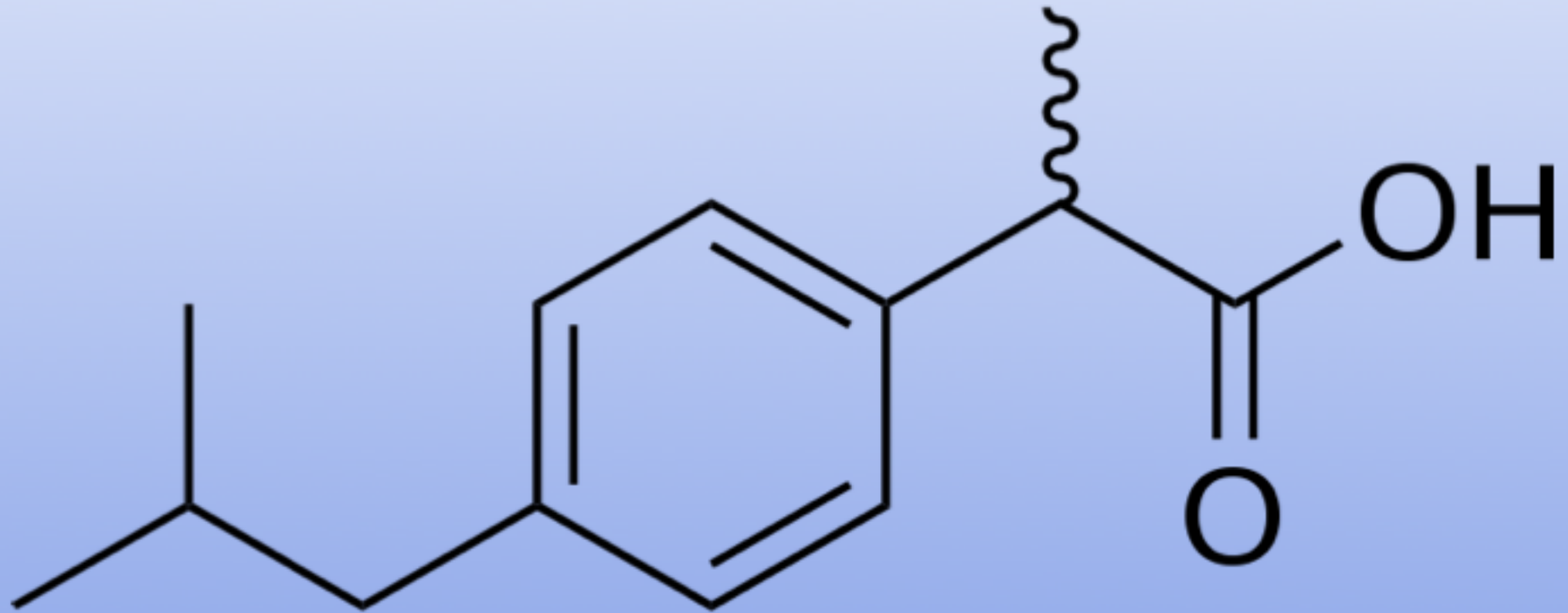
Two hurdles we will deal with

Understanding structures
Nomenclature



Ibuprofen

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

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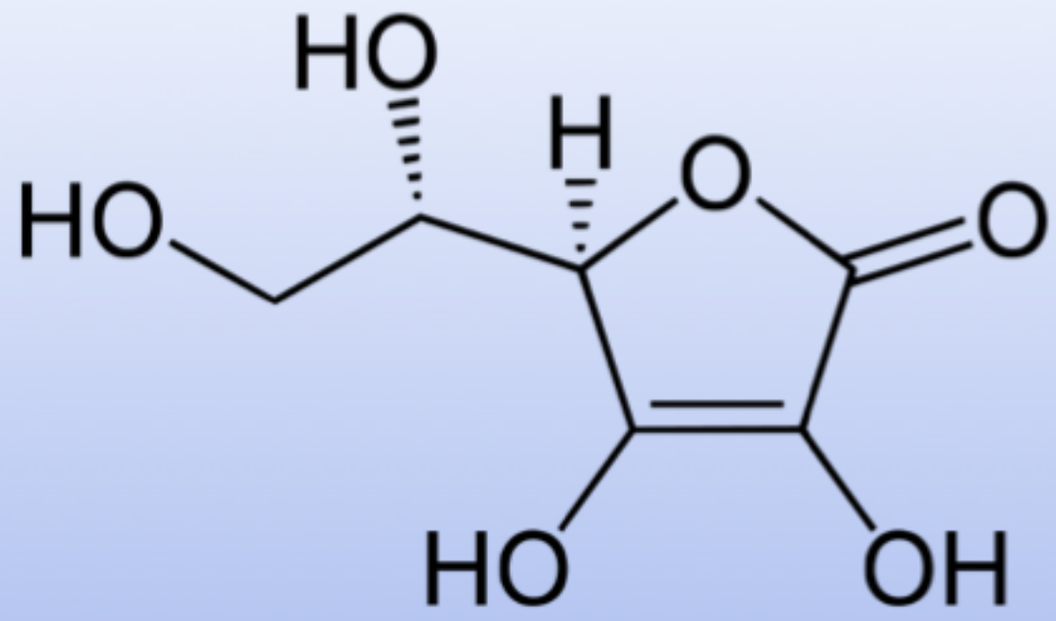

vitamin C

L-ascorbic acid

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

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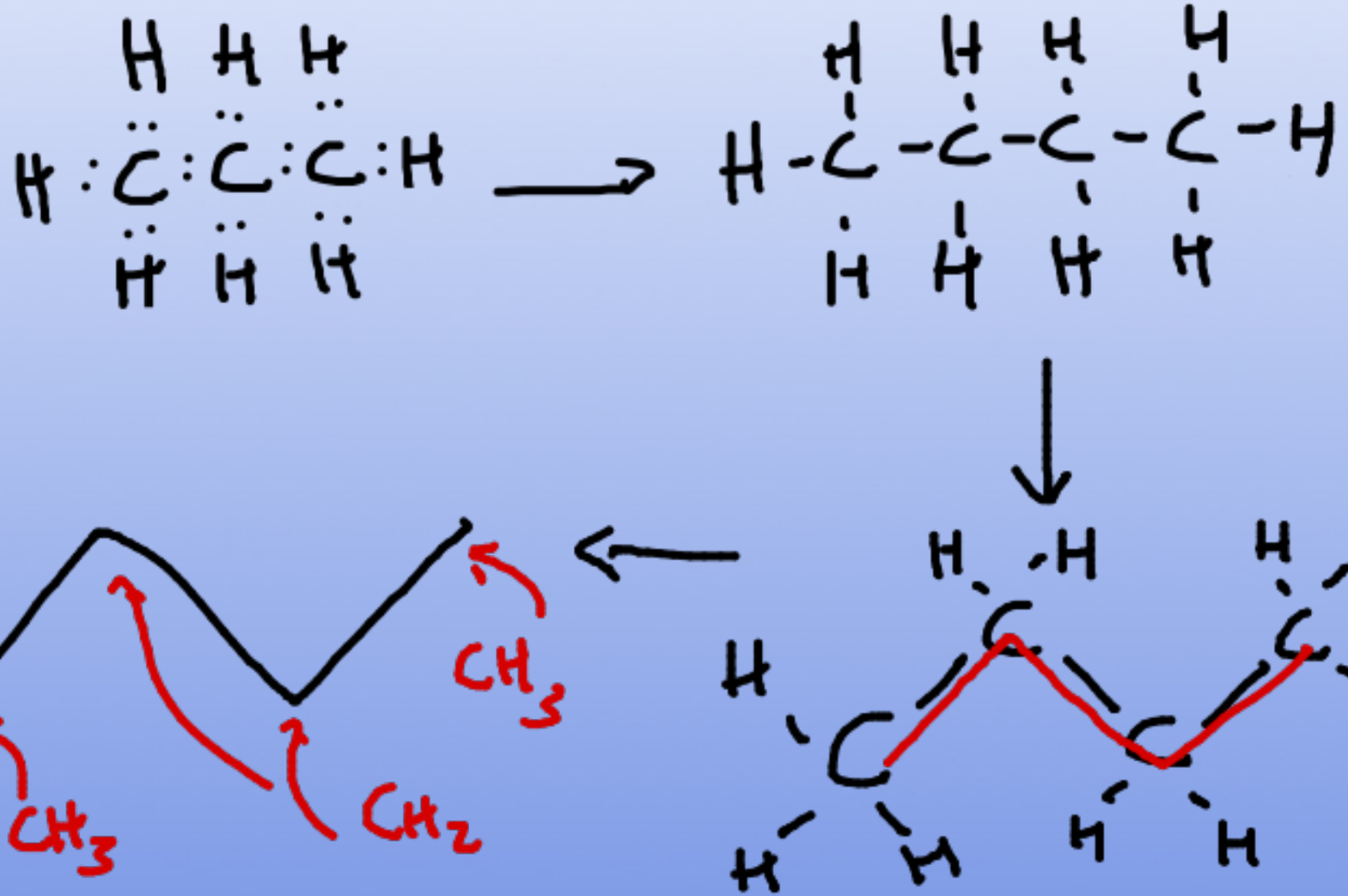
First Structures

Let's look at a simple molecule.

butane C_4H_{10}



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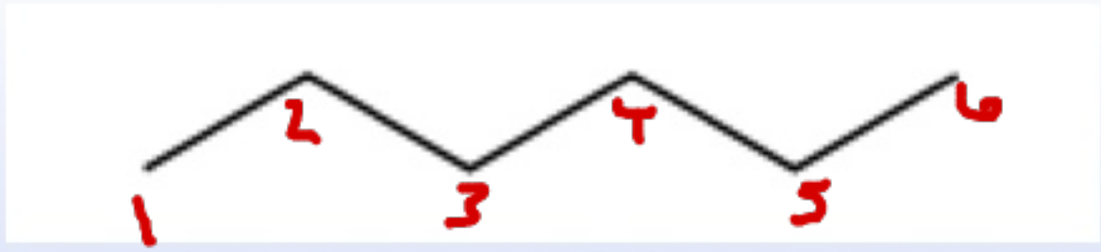
How many carbon atoms does this molecule have?



A. 0

B. 4

C. 5

D. 6

E. 7

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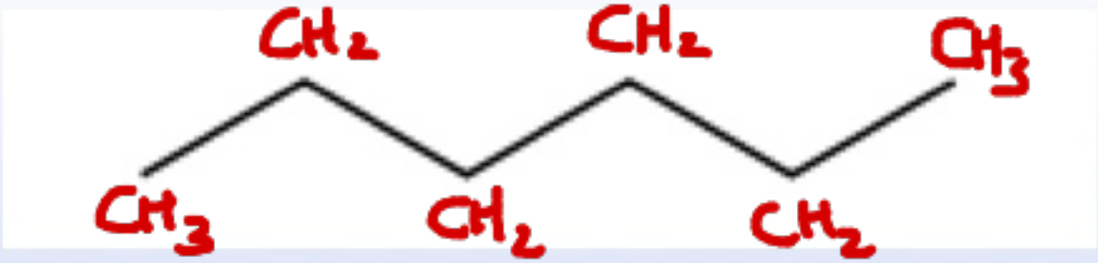
How many hyrdogen atoms does this molecule have?



A. 6

B. 10

C. 12

D. 14

E. 16

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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?

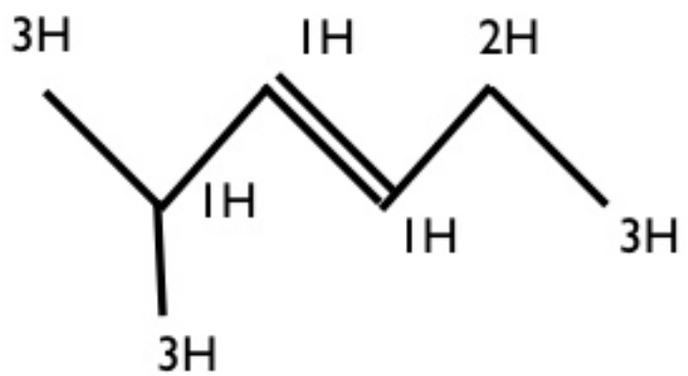
A. 6 C, 14 H

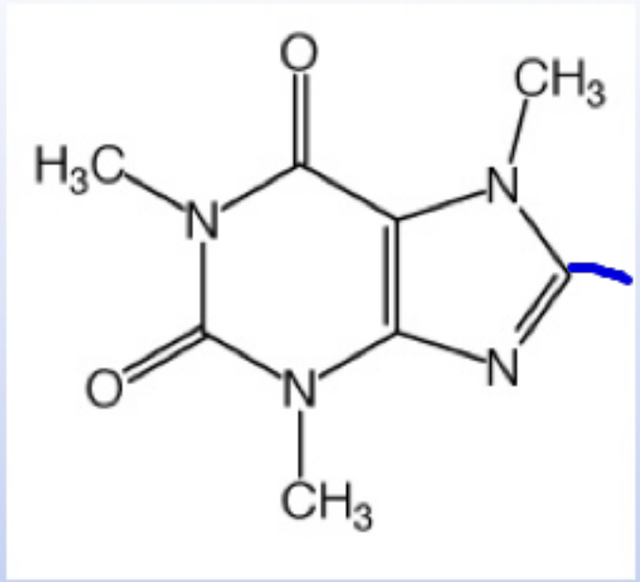
B. 6 C, 15 H

C. 6 C, 16 H

D. 7 C, 15 H

E. 7 C, 14 H





this is the structure for caffeine

how many hydrogens are not shown?

A. 0

B. 1

C. 2

D. 3

E. 4

C 4 Bonds

N 3 Bonds

O 2 Bonds

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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

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Step 1

Nomenclature

prefix parent suffix

suffix is the name of the "functional group"

-ol alcohol

-one ketone

-ane alkane

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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

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Names for parent groups

First lets look at alkanes
(essentially no functional group)

All single bonds

suffix is ane

methane butane 5-methyloctane

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SIDE CHAIN

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	$CH_3(CH_2)_{10}CH_2-$

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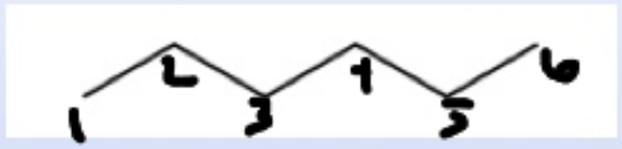
The following compound is

$CH_3CH_2CH_2CH_2CH_2CH_3$



A. butane

B. isobutane

C. pentane

D. hexane

E. heptane

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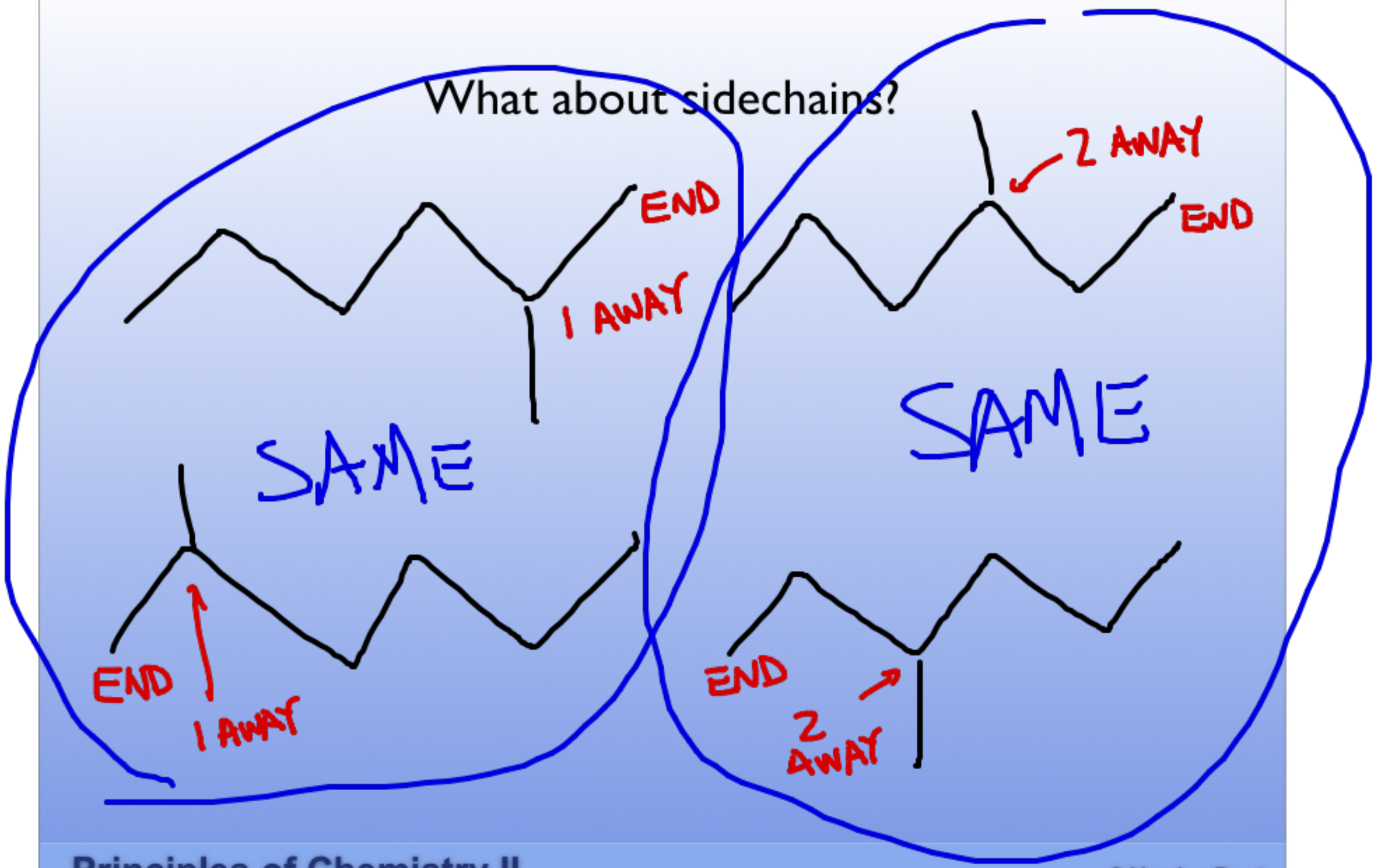
What about sidechains?



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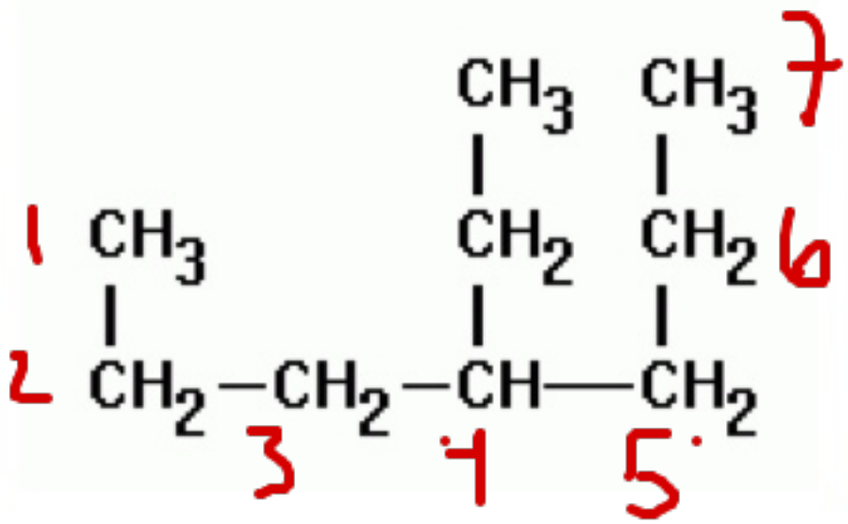
The following compound is



A. 3-ethylhexane

B. 3-ethylpropane

C. 4-propylhexane

D. 4-ethylheptane

E. 3-ethylocatne

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Which numbers do I use?

longest main chain
lowest possible numbers

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The next simplest
add a functional group

C=C Double bond

suffix -ene

C≡C Triple bond

suffix -yne

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Different Molecules

Since Double/triple Bonds have different reactivities.

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The following compound is

A. 2-hexene

B. 3-hexene

C. 4-heptene

D. 4-hexene

E. 2 methyl, butene

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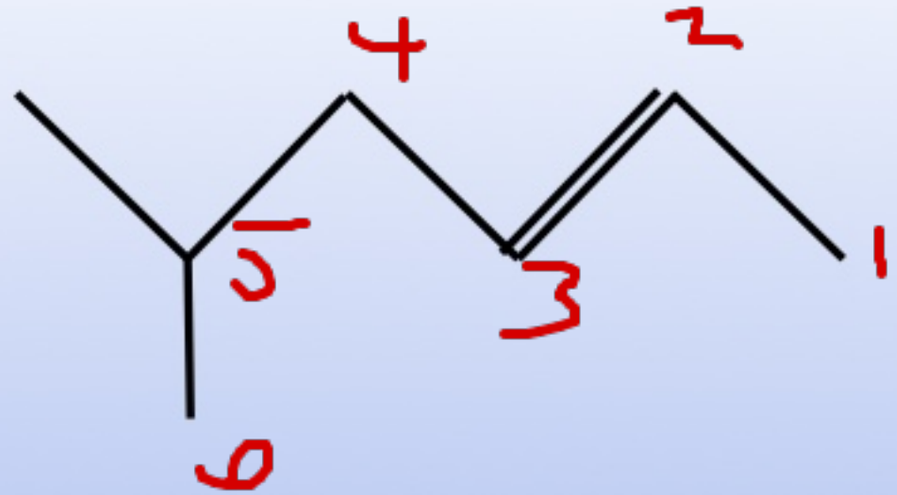
The following compound is



A. 5-methyl 2-hexene

B. 2-methyl 5-hexene

Lowest possible # for functional group

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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

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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

3 is lowest possible for functional group.

choose lowest choice for sidechain

P

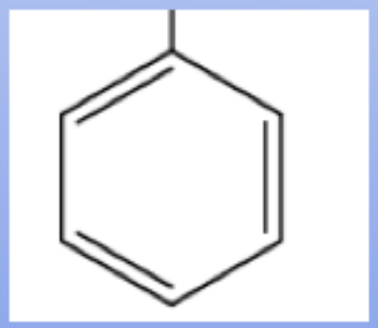
Other side-chains

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

OH group
hydroxy

NH_2 group
amino

Benzene Ring
phenyl



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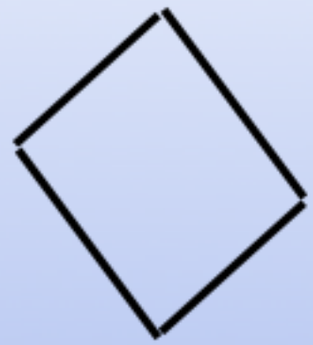
Cyclic Hydrocarbons
the carbon chain connects back to itself



cyclobutane

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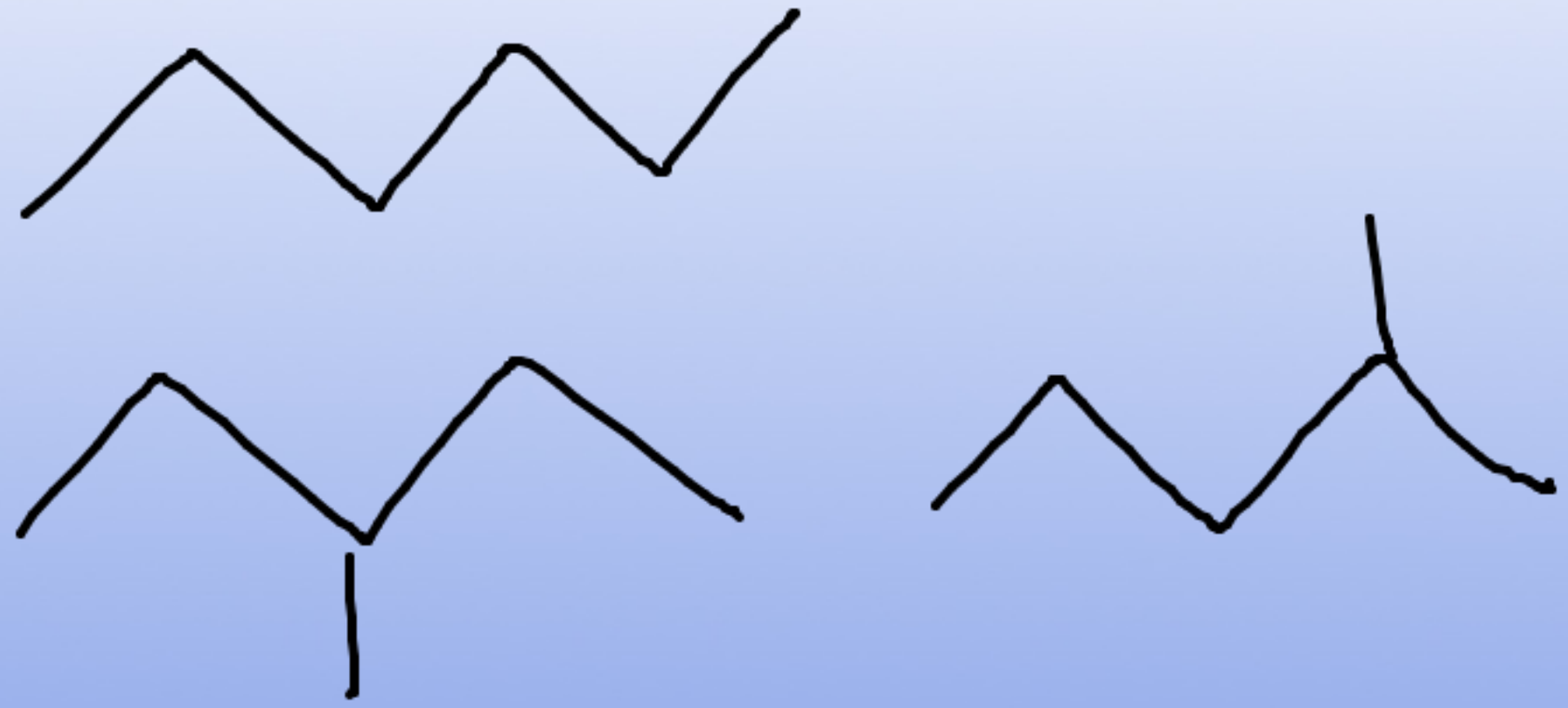
Structural Isomers

hexane (C_6H_{14})



All Hexanes

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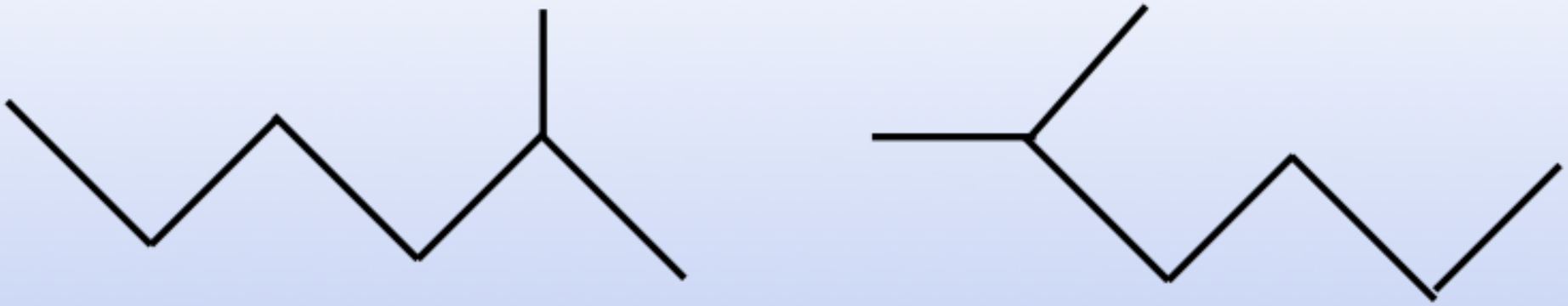
Are these the same molecule?



A. Yes
B. No

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Structural Isomer
(constitutional isomers)

Same atoms and bonds, different bonding pattern

Stereo Isomer
(spatial isomers)

Same bonding pattern, different orientations in space

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Structural isomers

n-hexane

2 methyl pentane

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Stereoisomers

Diastereomer
(can interconvert)

cis dichloro ethene

trans dichloroethene

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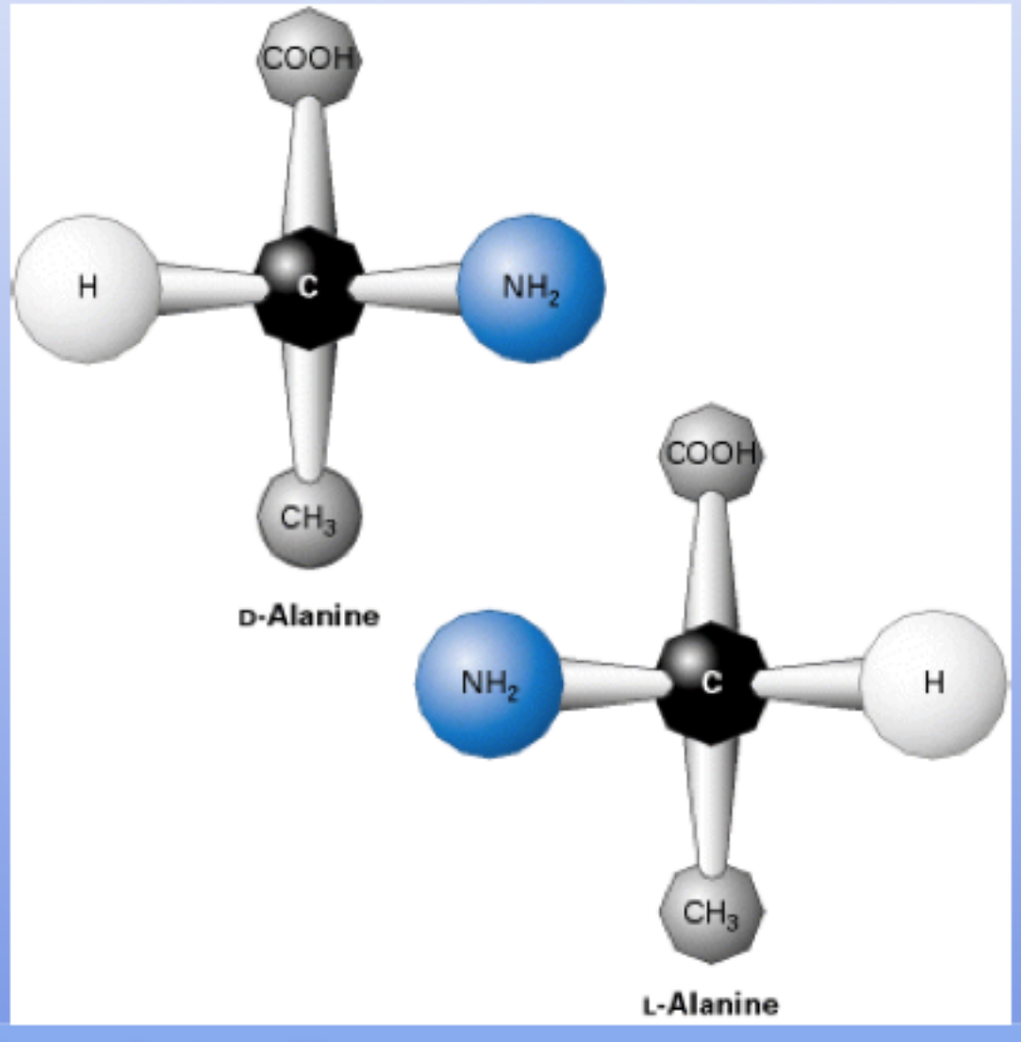
Stereoisomers

Enantiomers
(chiral molecules)

Molecules cannot be superimposed
(left and right hand versions)



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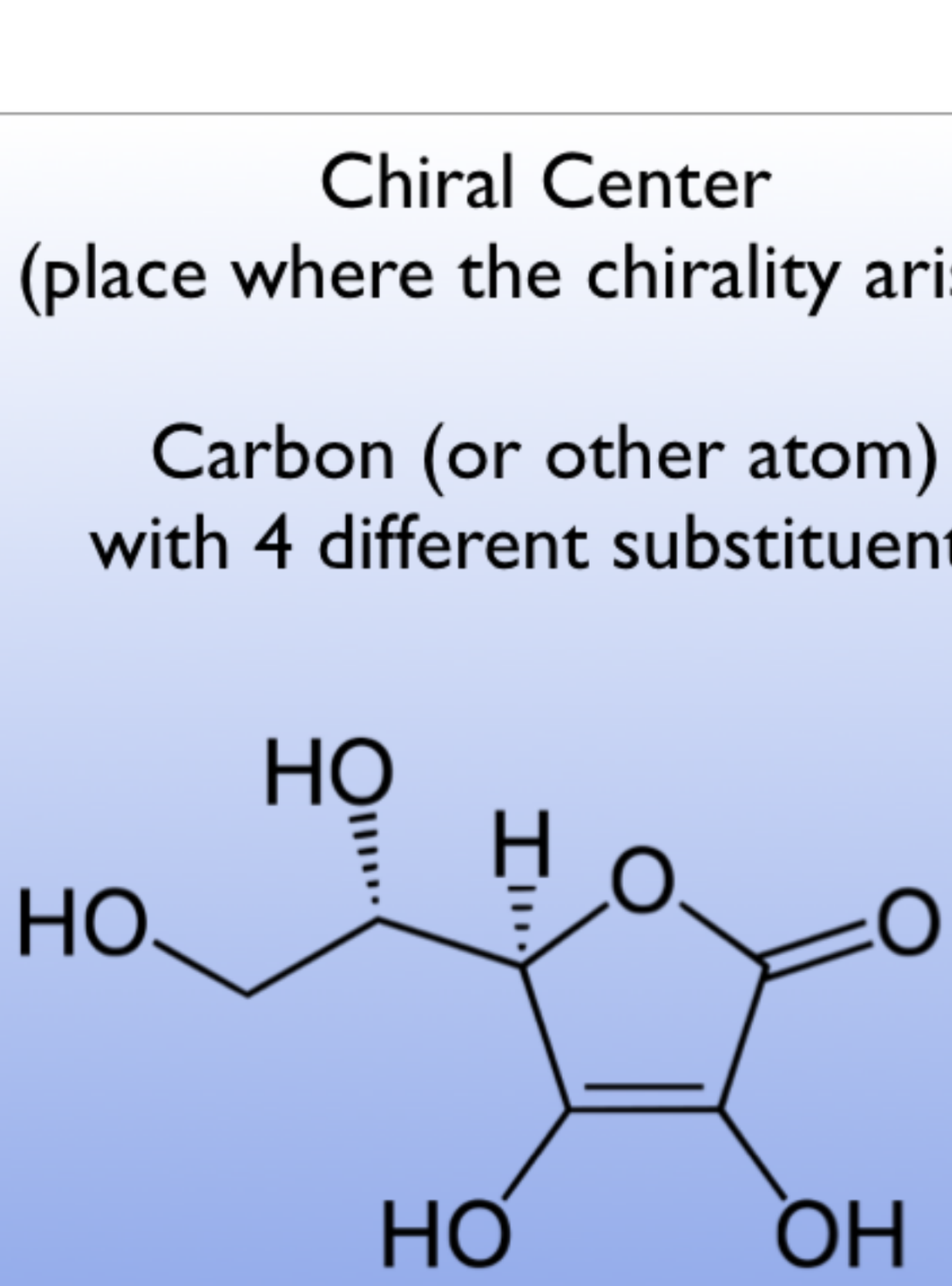
Chiral Center
(place where the chirality arises)

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

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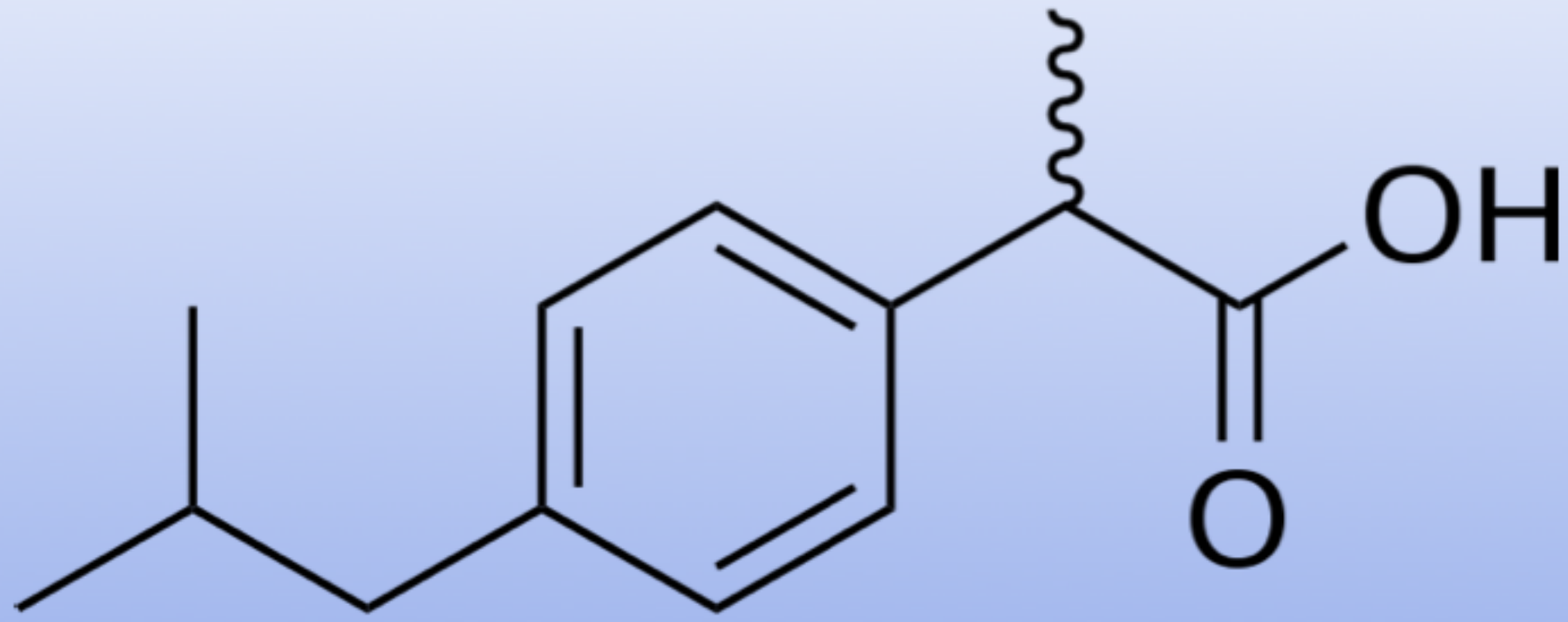

Ibuprofen

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

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Dienes

Two double bonds

5 carbon chain, parent
penta

no side chains

two double bonds diene
position 1 and 3

penta-1,3-diene

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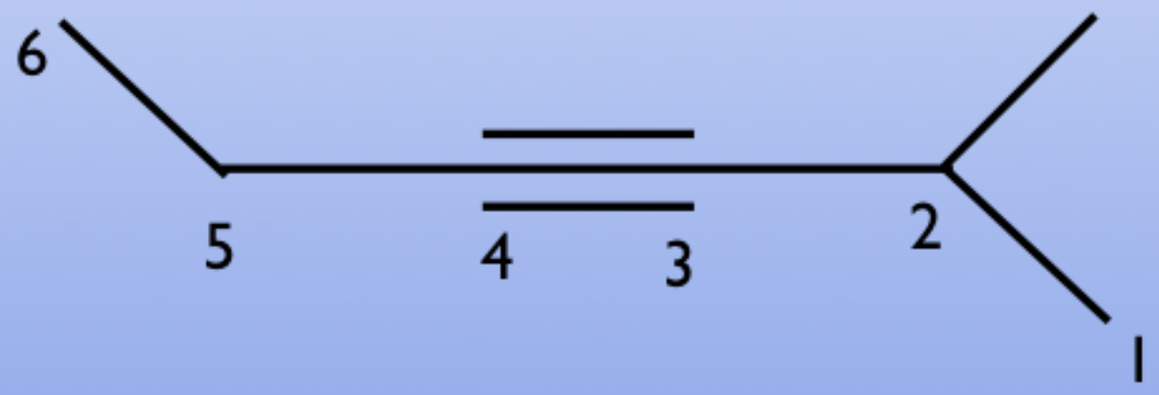
Alkyne

Carbon Carbon Triple Bond

Suffix -yne



2 methyl hex-3-yne

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Other functional groups

Common
Ethanol

$$R-OH$$

R = Generic representation
of the rest of the molecule

functional group

-OH group is an alcohol
suffix is -ol

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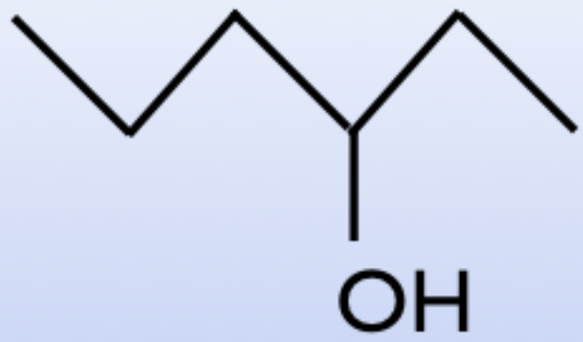
Name this compound



A. heptan-2-ol

B. hexan-4-ol

C. 2-ethylbutan-1-ol

D. 2-ethylpentan-1-ol

E. hexan-3-ol

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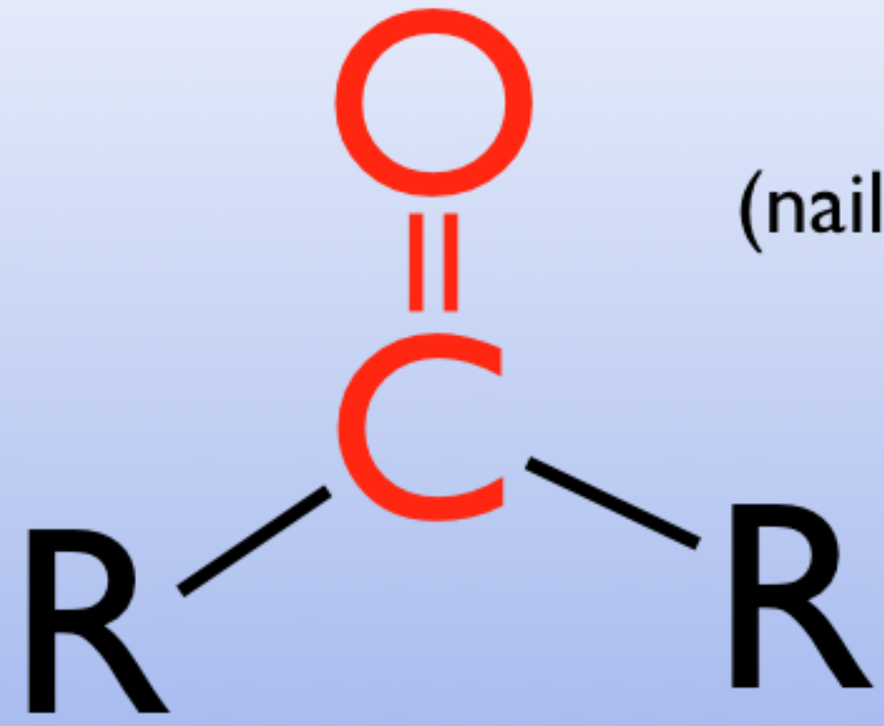
Ketone



Common
Acetone
(nail polish remover)

carbon double bonded to an oxygen
bonded to carbons on either side

suffix is -one

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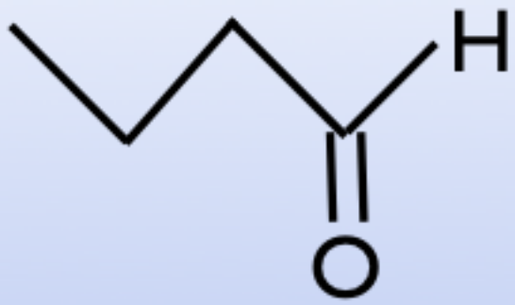
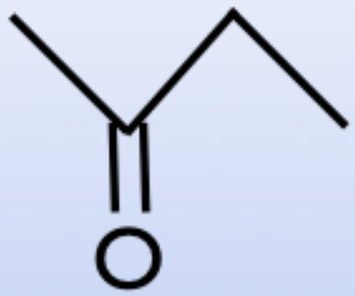
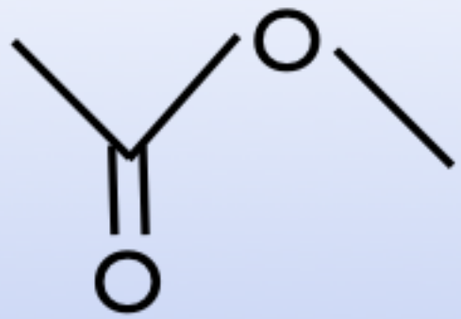
Which of the following is a ketone?



A



B



C

A. A

B. B

C. C

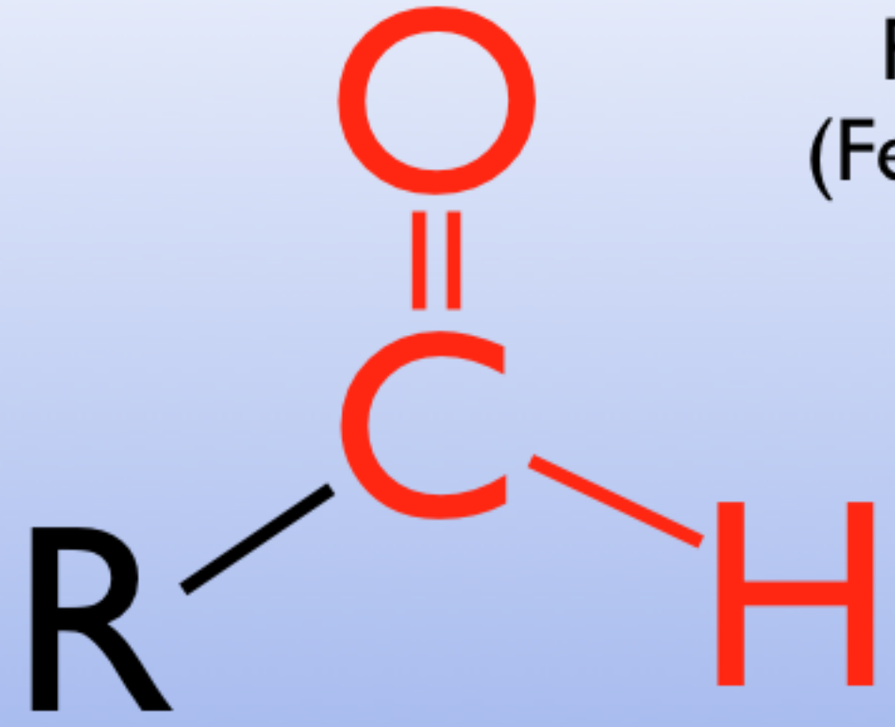
D. A & B

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

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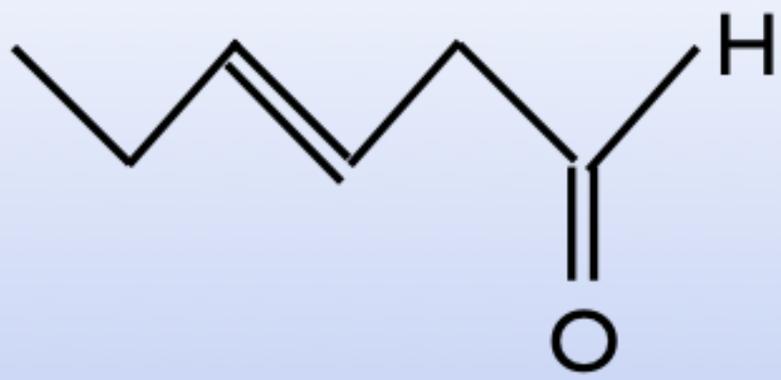
Name this compound



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

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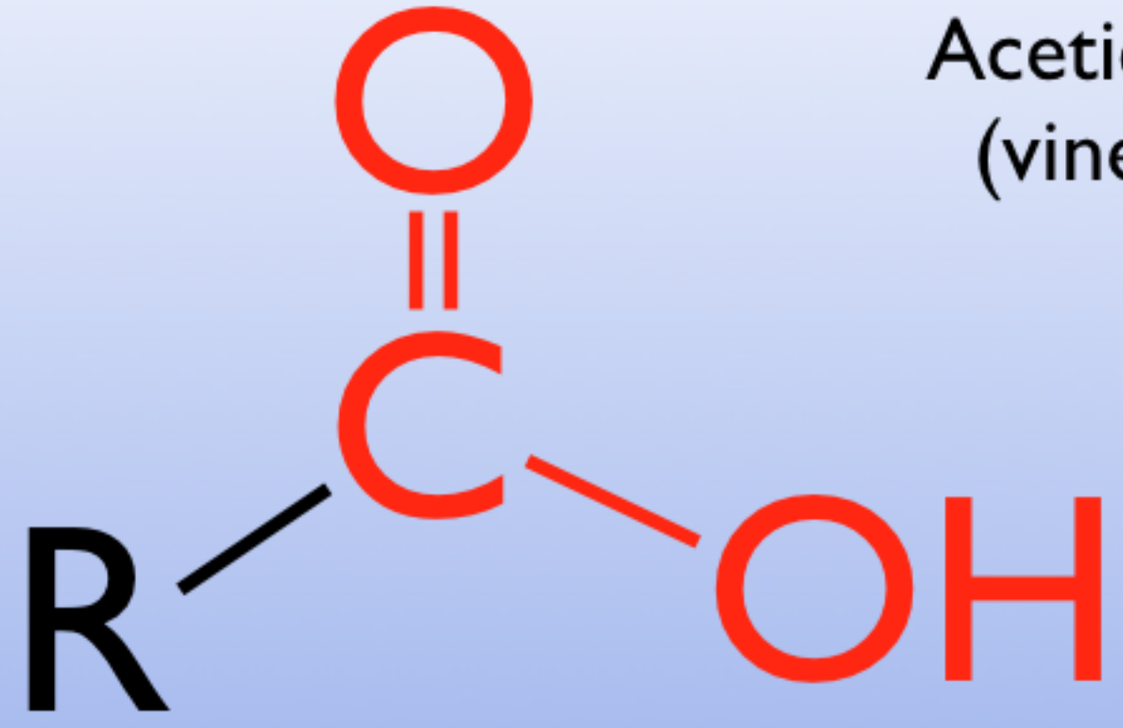
Carboxylic Acid



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

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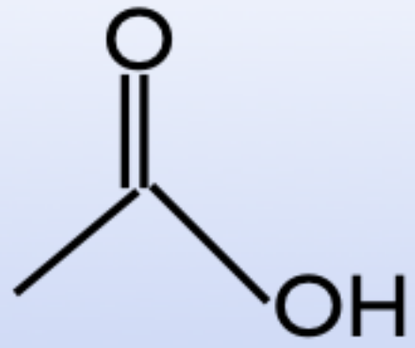
Name this compound



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

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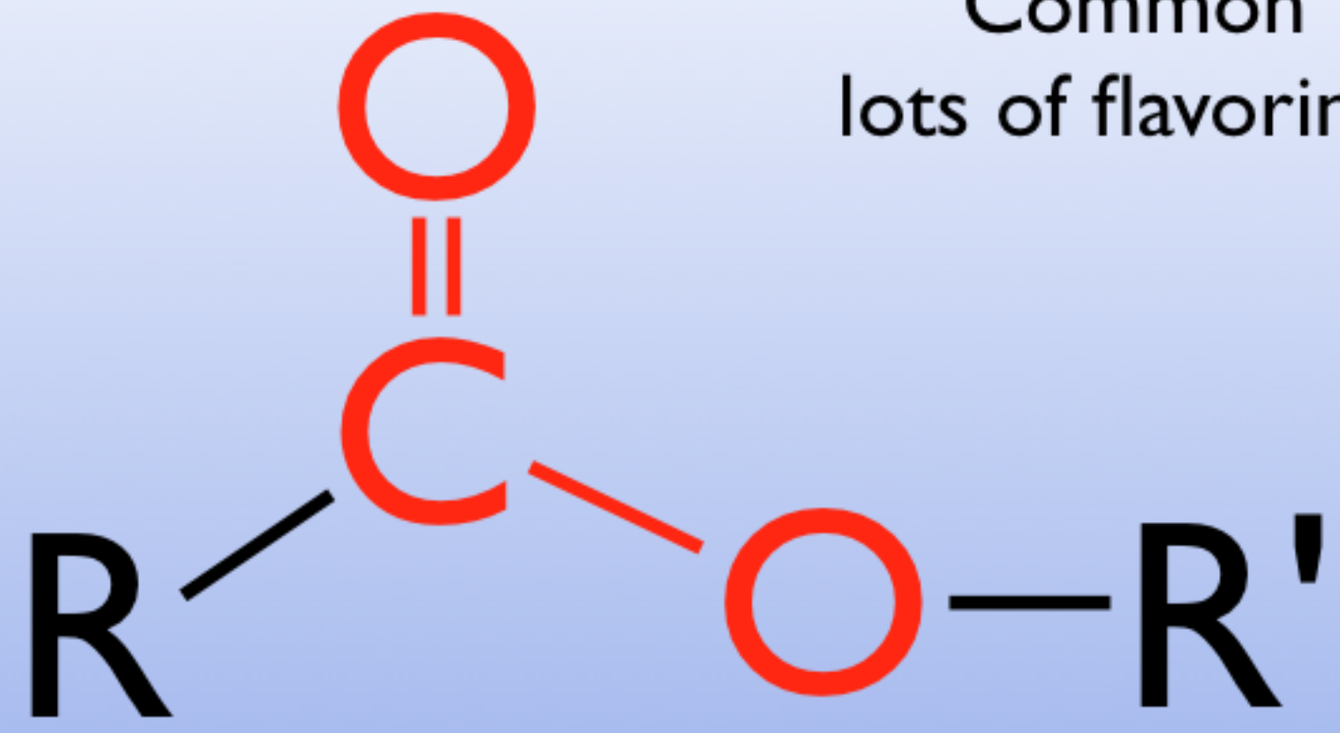
Ester

Common
lots of flavorings

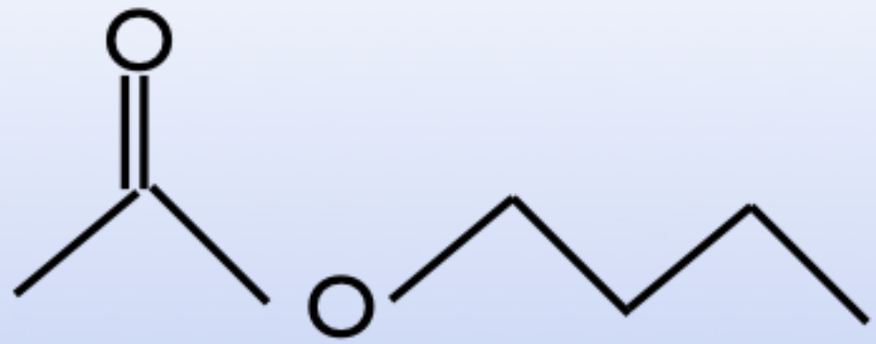


carbon double bonded to an oxygen
bonded to carbon on one side
OR on the other side

suffix is -oic acid

© Vanden Bout

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

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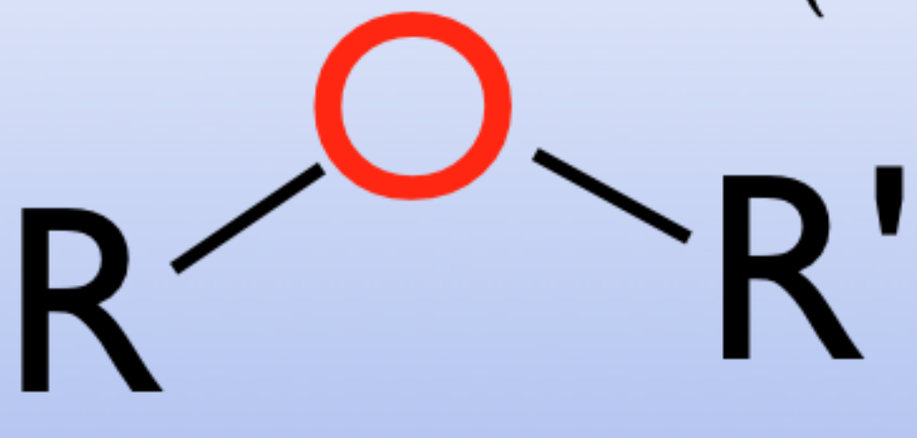
Ether

Diethyl Ether
(knocks you out)



carbon oxygen in the middle of the chain

suffix is -ether

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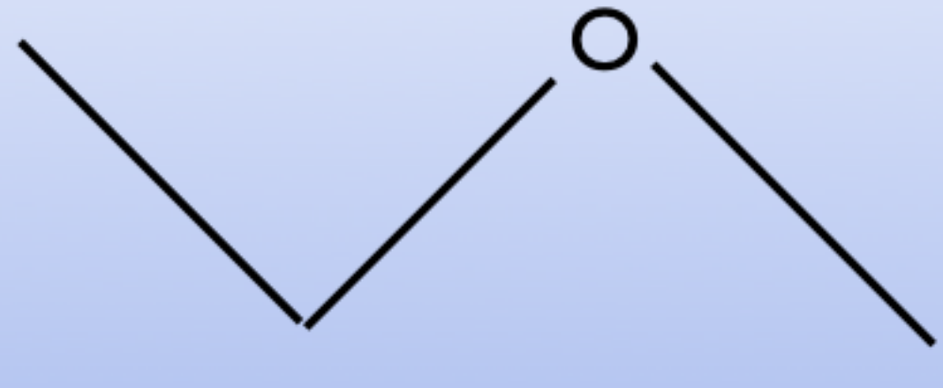

Treat as two "side chains"

methyl ethyl ether

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Primary Amine

-NH_2 group is an amine
suffix is -amine

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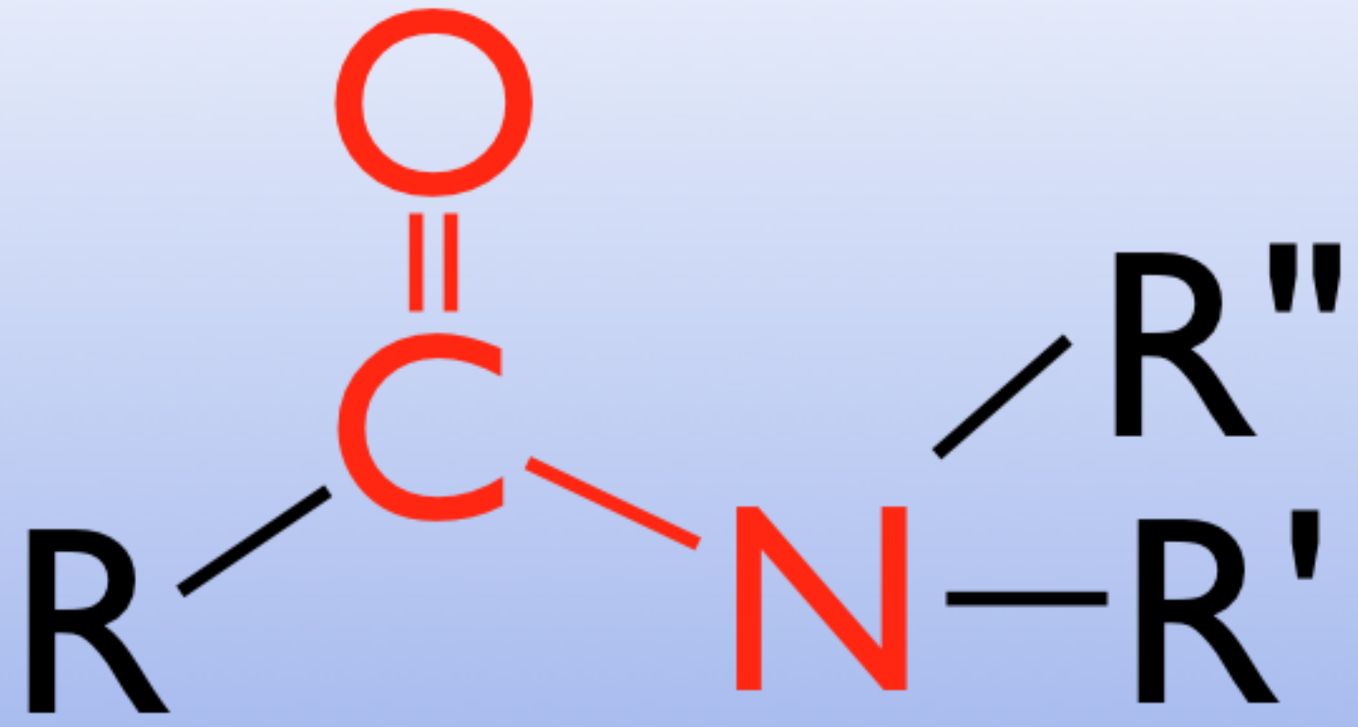
Amide



carbon double bonded to an oxygen
bonded to carbon on one side
N on the other side
suffix is -amide

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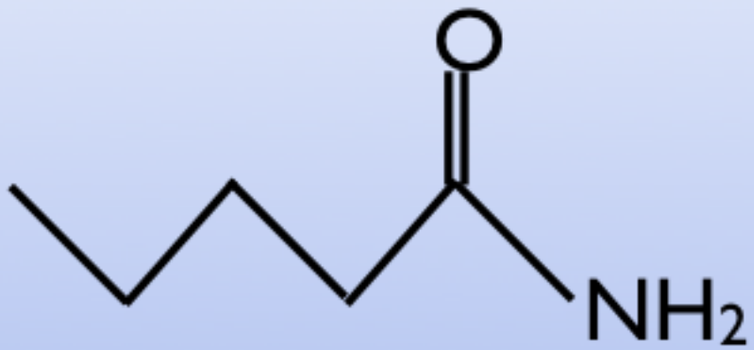
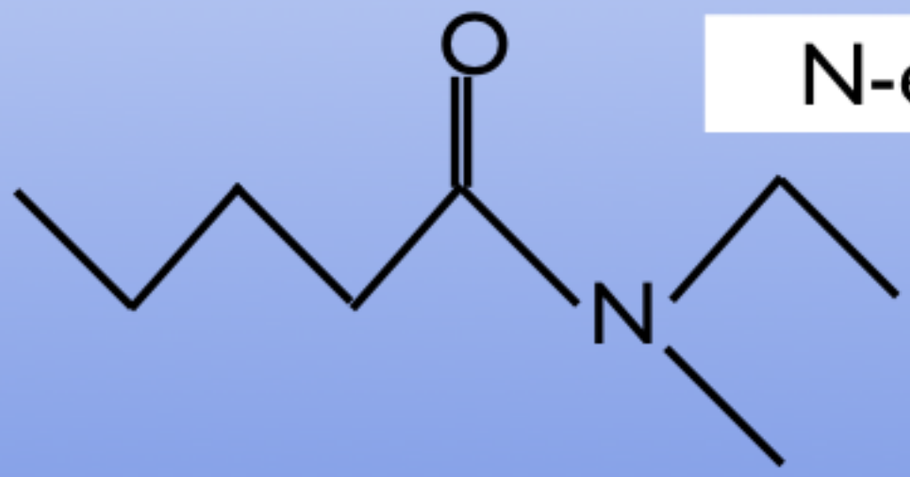
Naming amide

Treat part with C=O as parent

parts on the N as sidechains



pentanamide



N-ethyl-N-methylpentanamide

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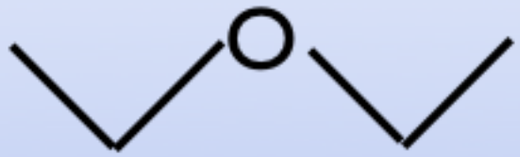
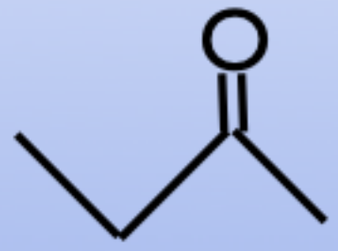
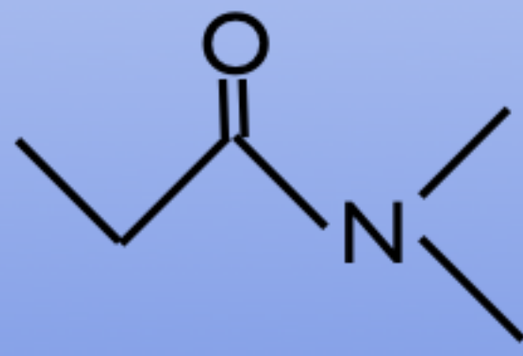
Amine



Ether



Ketone



Amide

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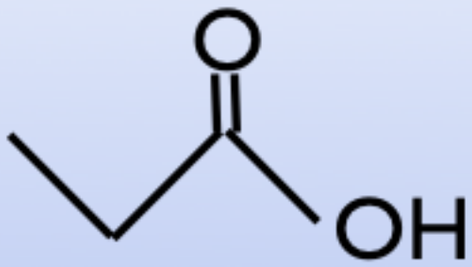
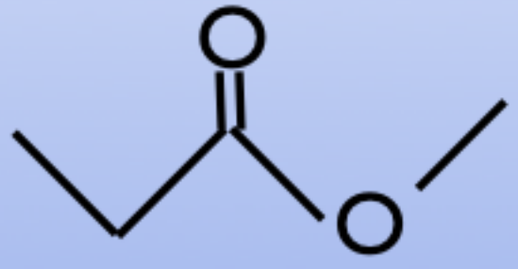
Alcohol



Carboxylic Acid



Ester

Alkene

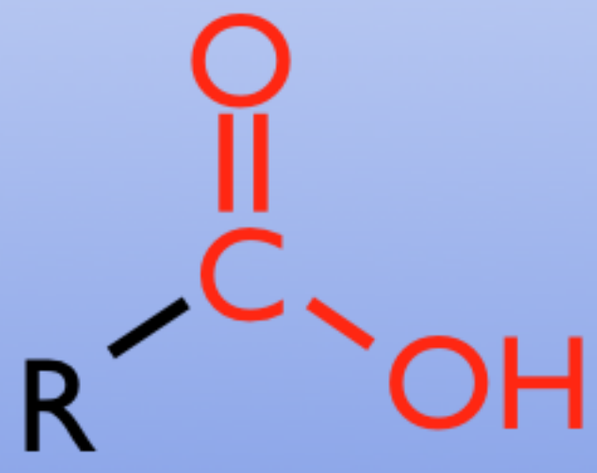
© Vanden Bout

Important Reaction for Biochemistry

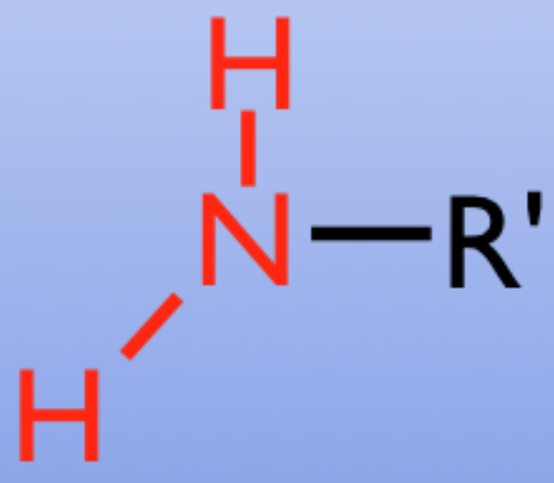
Formation of an Amide

The don't call them functional groups for nothing

Carboxylic Acid



Primary Amine



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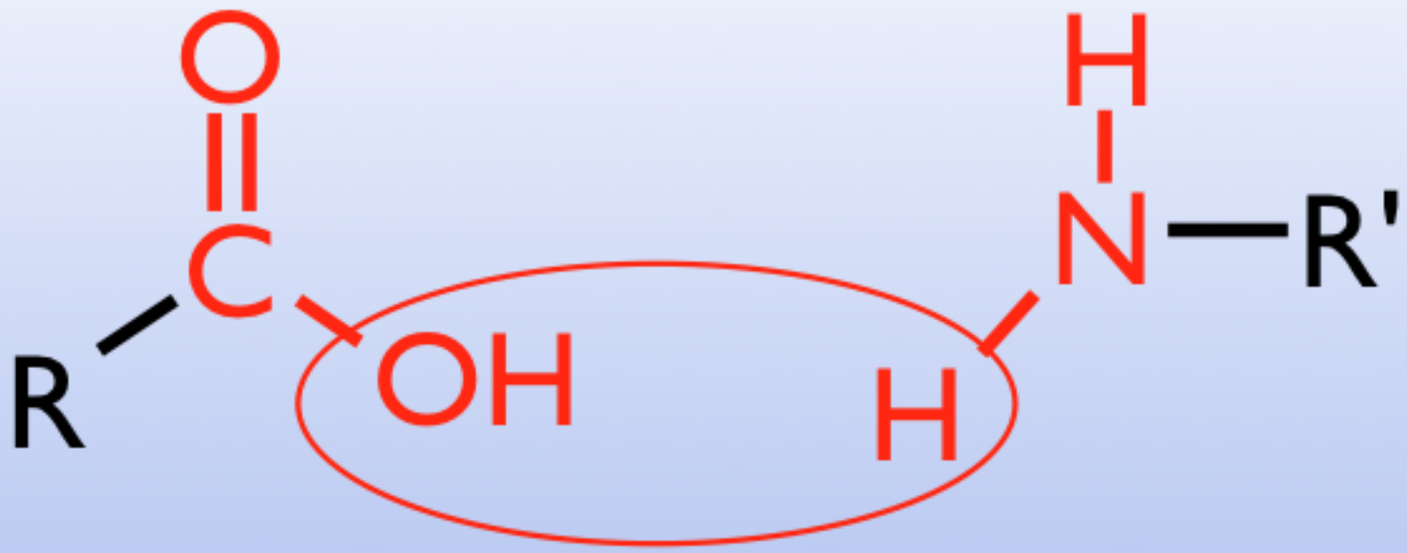
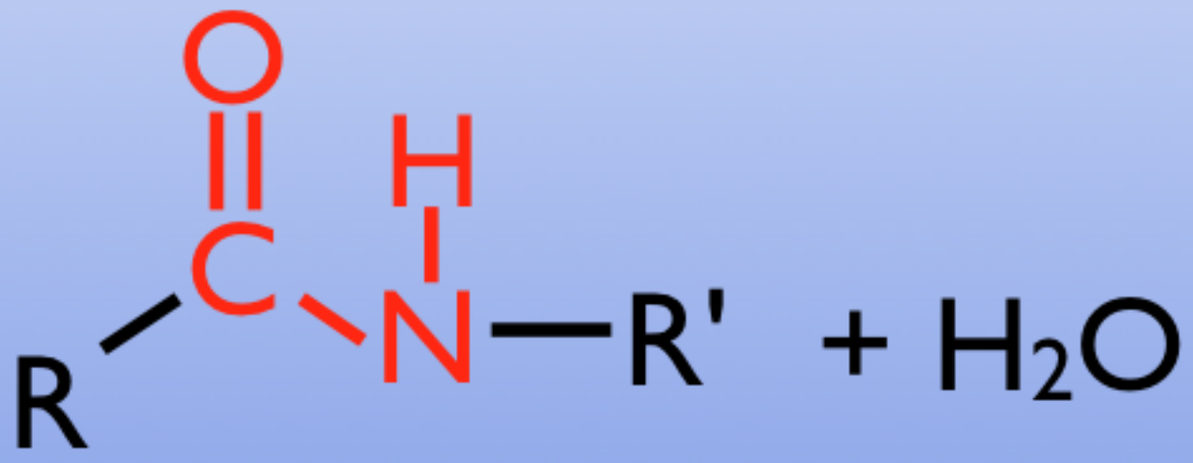
Carboxylic Acid

Primary Amine





Amide + Water

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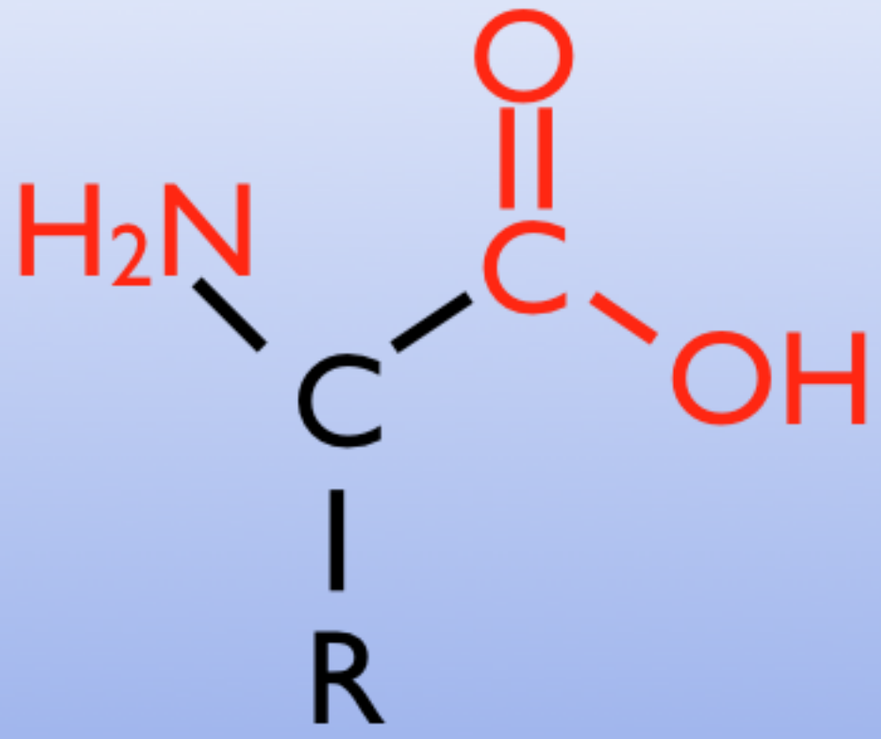
Amino Acid



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

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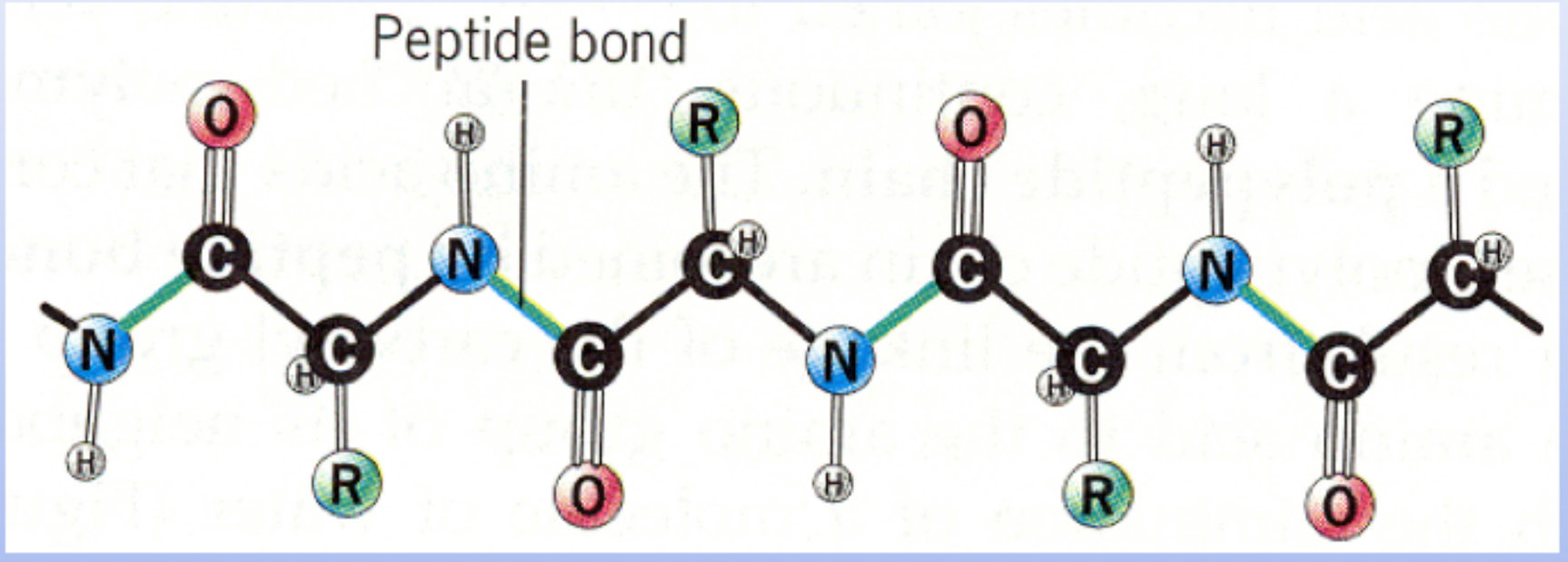
Polypeptide



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

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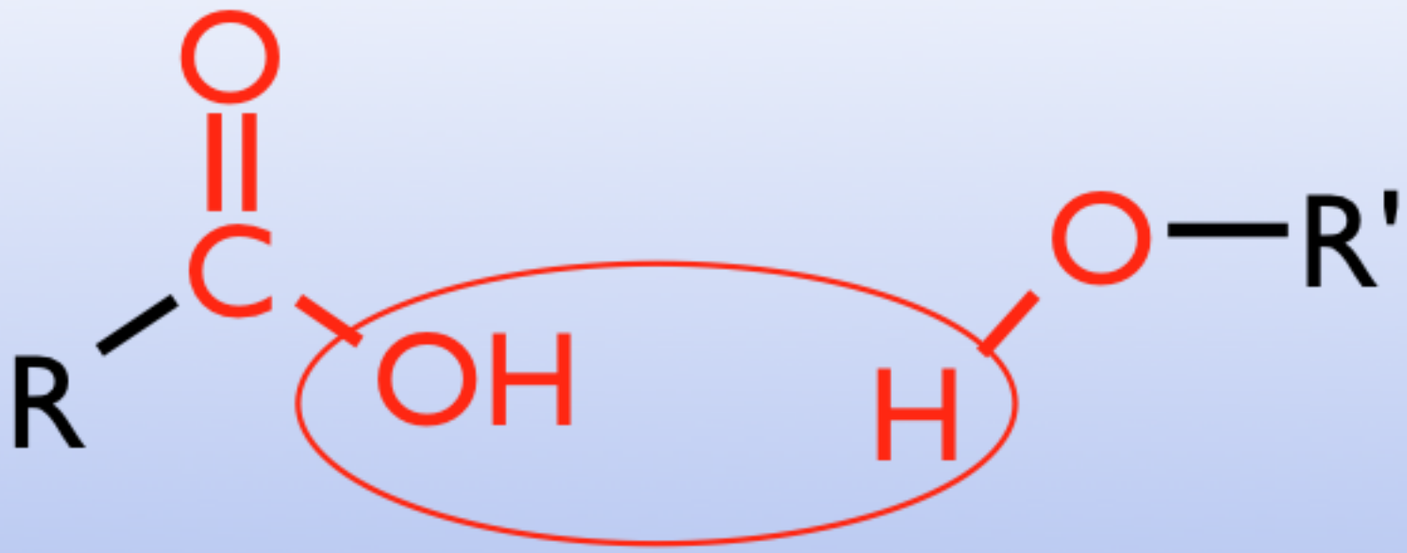
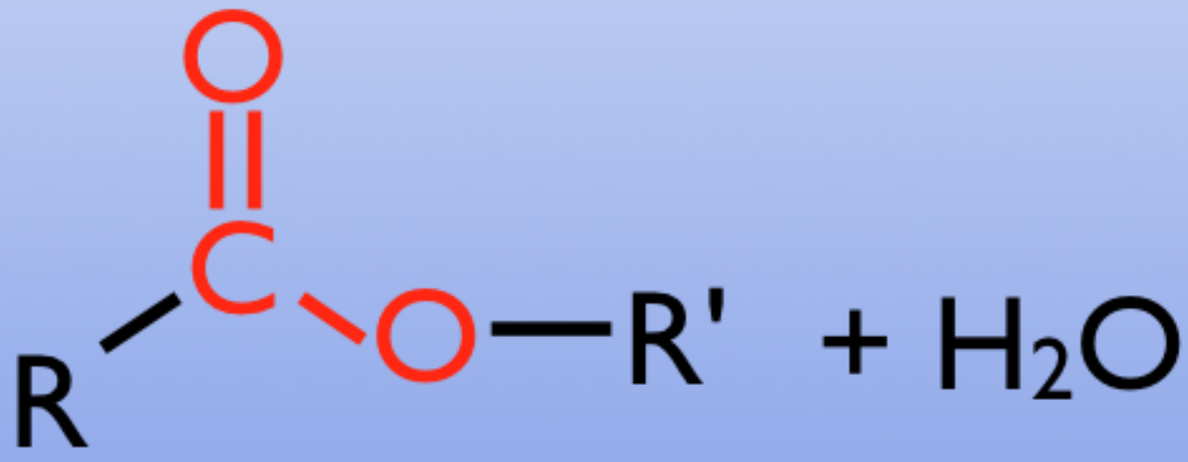
Carboxylic Acid

Alcohol



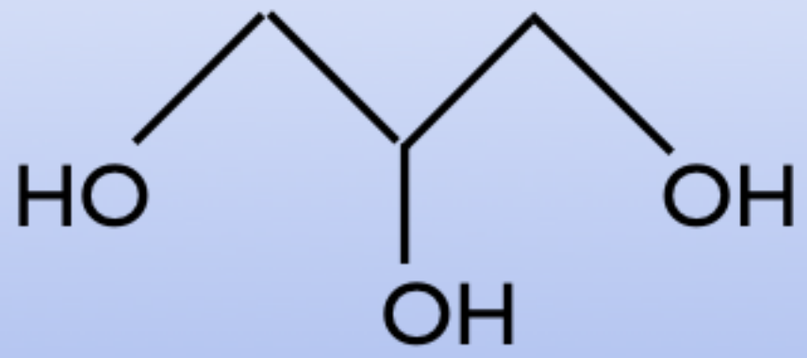


Ester + Water

© Vanden Bout

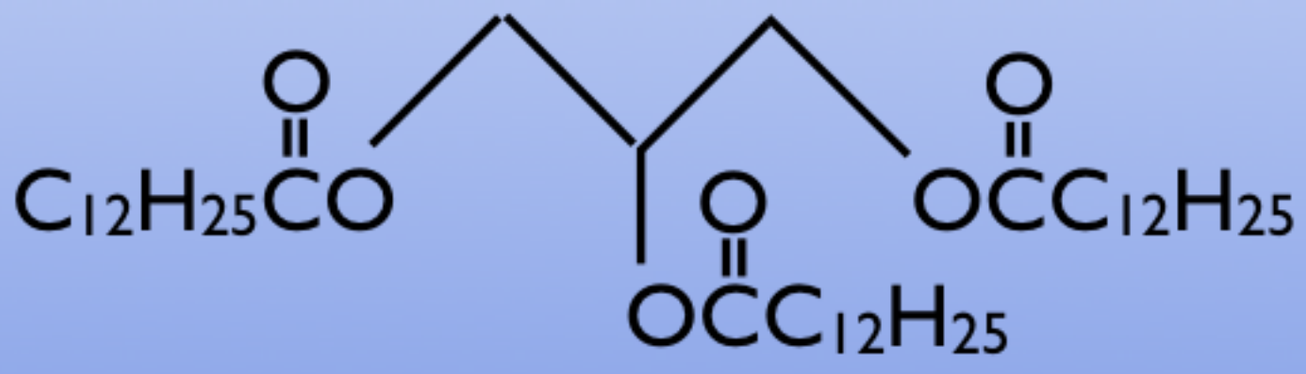
Triglycerides

Gylcerol



Fatty Acid
(carboxylic acid with long chain)

$C_{12}H_{25}COOH$



Makes Trigylceride

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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

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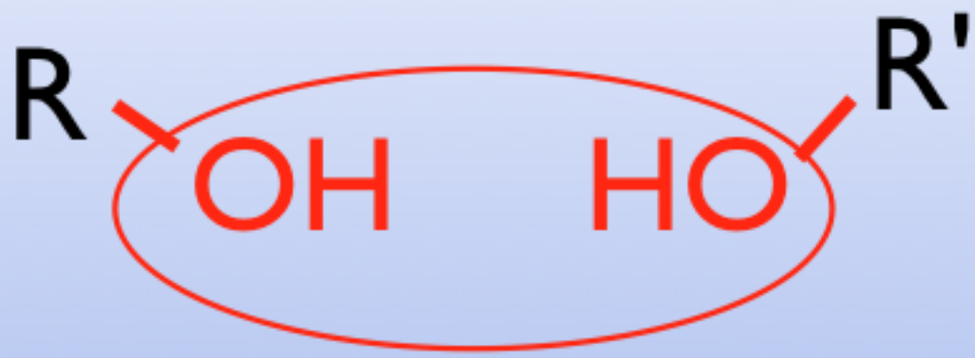
Alcohol Alcohol



Ether + Water

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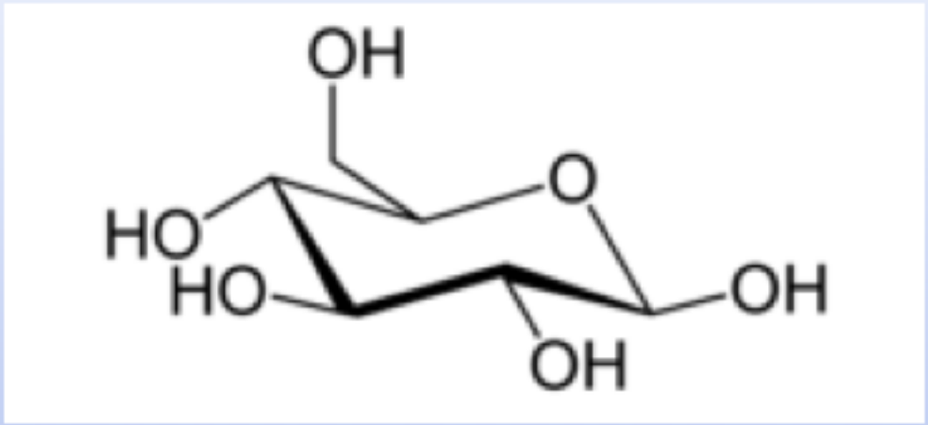
Sugars



Glucose

(key factor for sugars lots of hydroxyls)

They can react to form chains of sugars

polysaccharide

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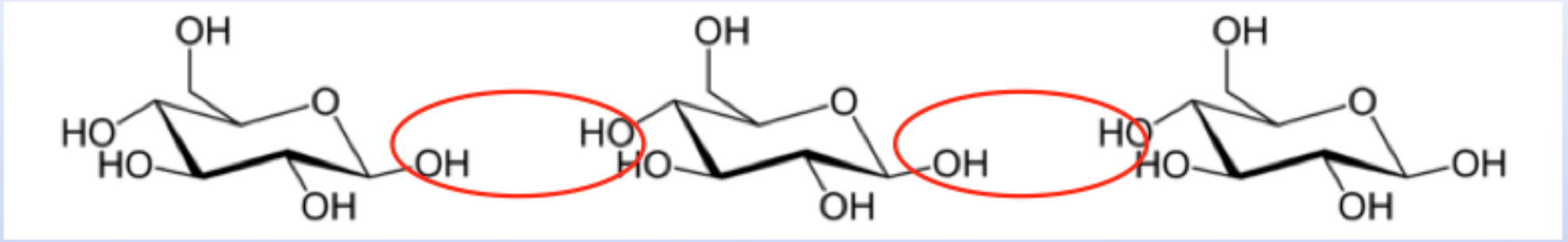
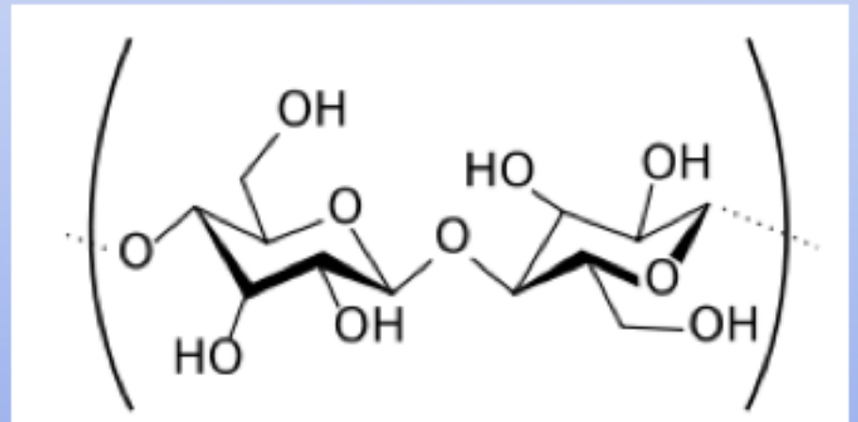
Celluose





Very long ether chain
(pretty much all plant material)

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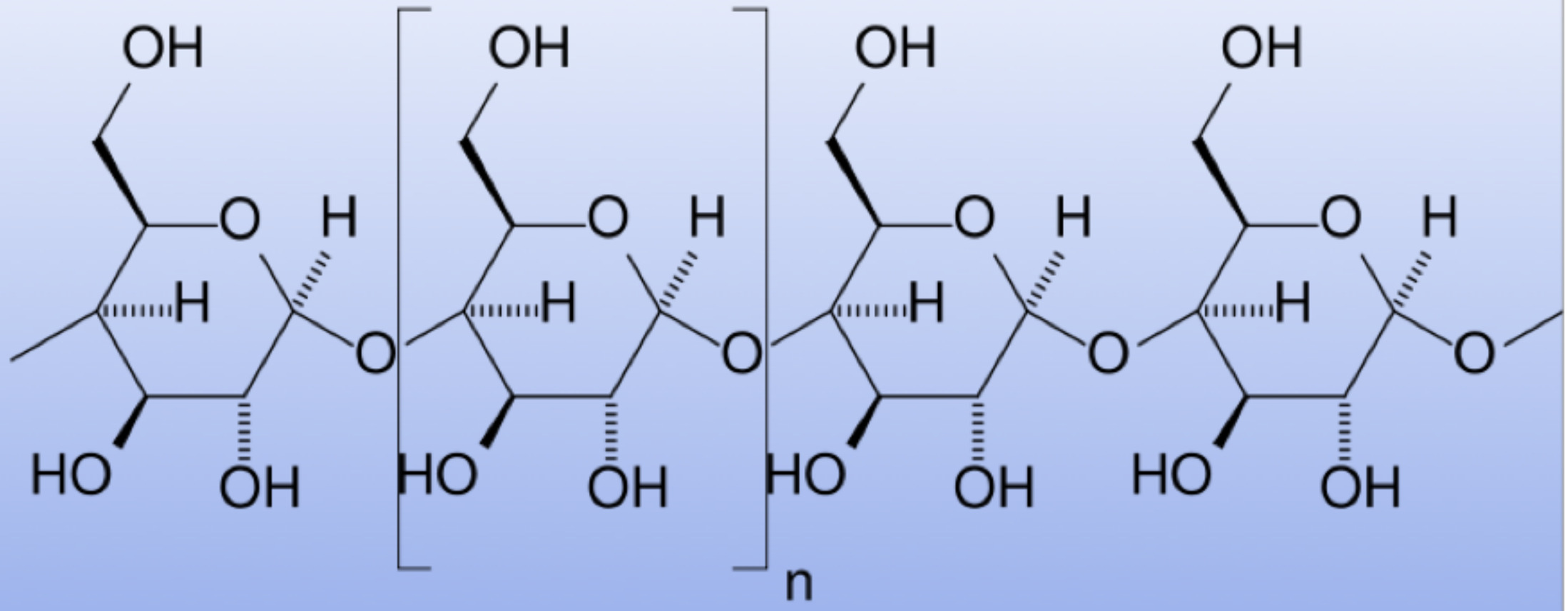
Polysaccharide (Starch)



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

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Condensation Reactions
(two molecules make one + water)

Carboxylic Acid + Amine = Amide + water

Carboxylic Acid + Alcohol = Ester + water

Alcohol + Alcohol = Ether + water

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