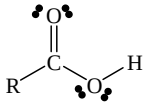
Generic Functional Group Pattern in ordero of nomenclature priority in our course.	Specific Example Using Suffix (2D and 3D) when highest priority FG	Specific Example Using Prefix when lower priority FG

1. carboxylic acid (2D)



suffix: -oic acid

prefix: #-carboxy

Condensed line formula

RCO_2H or HO_2CR

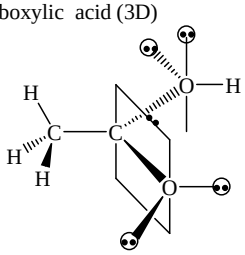
$RCH(CO_2H)R'$

FG on the right

FG in the middle

FG on the left

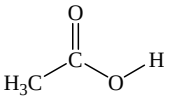
carboxylic acid (3D)



carbonyl resonance (C=O) is possible

IUPAC: ethanoic acid

common: acetic acid



(2D)

prefix example

#-carboxy

not used in our course (acids are the highest priority group that we use)

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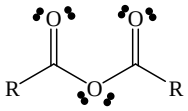
2. anhydride (2D)



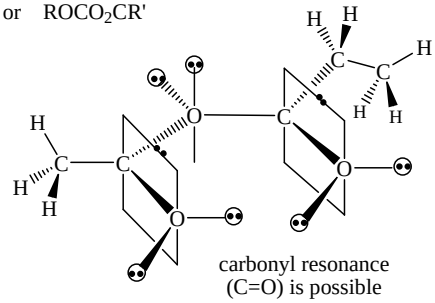
suffix: -oic -oic anhydride (just one -oic anhydride, if symmetrical)

prefix: #-acyloxyalkanecarbonyl (prefix not required for us)

Condensed line formula

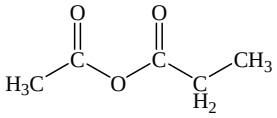
RCO_2COR' or $ROCO_2CR'$

anhydride (3D)



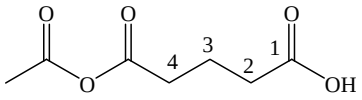
carbonyl resonance (C=O) is possible

IUPAC: ethanoic propanoic anhydride



(2D)

prefix example



4-acyloxymethanebutanoic acid

(prefix not required for us - too difficult)

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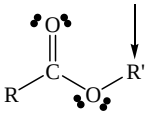
3. ester (2D)

alkyl name (goes in front as separate word)



prefix: alkyl suffix: -oate

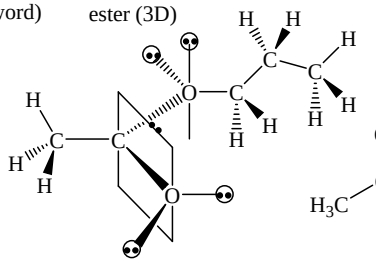
prefix: #-alkoxycarbonyl

Condensed line formula

RCO_2R' or $R'O_2CR$

$RCH(CO_2CH_3)R'$

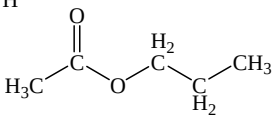
ester (3D)



carbonyl resonance (C=O) is possible

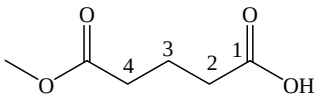
IUPAC: propyl ethanoate

common: propyl acetate



(2D)

prefix example



4-methoxycarbonylbutanoic acid

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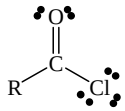
4. acid chloride (2D)



suffix: -oyl chloride

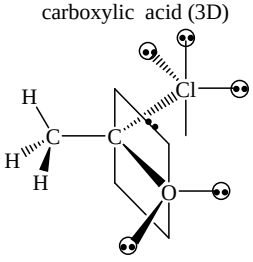
prefix: #-chlorocarbonyl

Condensed line formula

RCOCl or ClOCR

$RCH(COCl)R'$

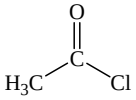
carboxylic acid (3D)



carbonyl resonance (C=O) is possible, but weak because of the poor overlap of the chlorine 3p orbital with the carbon 2p orbital

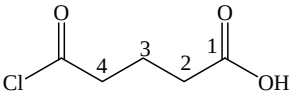
IUPAC: ethanoyl chloride

common: acetylchloride



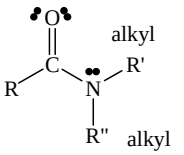
(2D)

prefix example



4-chlorocarbonylbutanoic acid

5. amides (1^o,2^o,3^o) (2D)

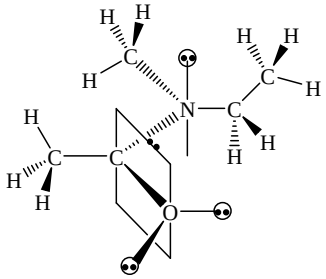


Condensed line formula

$RCONR_2$ or R_2NOCR

$RCH(CONH_2)R'$

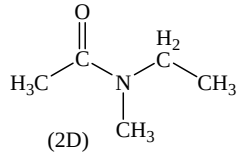
3^o amide (3D)



carbonyl resonance (C=O) is possible, it is especially strong in amides

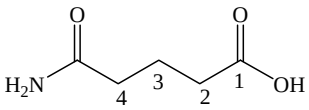
IUPAC: N-ethyl-N-methylethanamide

common: N-ethyl-N-methylacetamide



(2D)

prefix example



4-amidobutanoic acid
or
4-carbamoylbutanoic acid

when highest priority functional group
1^o amides: suffix: -amide
2^o amides: prefix: N-alkyl suffix: -amide
3^o amides: prefix: N-alkyl-N-alkyl suffix: -amide

prefix when lower priority functional group:
1^o amides: prefix: #-amido or #-carbamoyl
2^o amides: prefix: #-(N-alkylamido) or #-(N-alkylcarbamoyl)
3^o amides: prefix: #-(N-allkyl-N-alkylamido) or #-(N-alkyl-N-alkylcarbamoyl)

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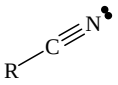
6. nitrile (2D)



suffix: nitrile
(don't drop the final "e" of the stem name)

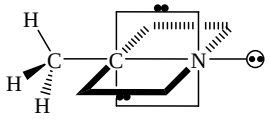
prefix: #-cyano

Condensed line formula

RCN or NCR

RCH(CN)R'

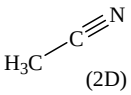
nitrile (3D)



nitrile resonance (C^oN) is possible

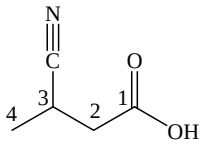
IUPAC: ethanenitrile

common: acetonitrile



(2D)

prefix example



3-cyanobutanoic acid

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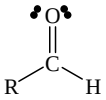
7. aldehyde (2D)



suffix: -al

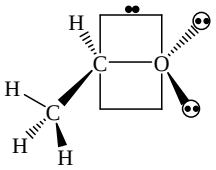
prefix: #-oxo (if part of longest chain)
#-formyl (if branch off of longest chain)

Condensed line formula

RCHO or OHCR

RCH(CHO)R'

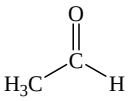
aldehyde (3D)



carbonyl resonance (C=O) possible

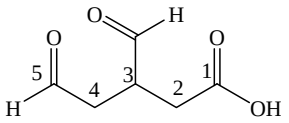
IUPAC: ethanal

common: acetaldehyde



(2D)

prefix examples



3-formyl-5-oxopentanoic acid

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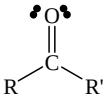
8. ketone (2D)



suffix: -#-one

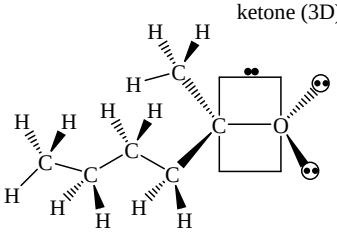
prefix: #-oxo (older = #-keto)

Condensed line formula

R_1COR_2 or R_2OCR_1

$RCH(COCH_3)R'$

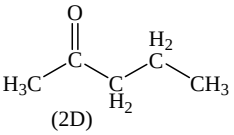
ketone (3D)



carbonyl resonance (C=O) possible

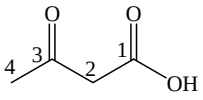
IUPAC: pentan-2-one

former: 2-pentanone



(2D)

prefix example



3-oxobutanoic acid

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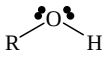
9. alcohol (2D)



suffix: -#-ol

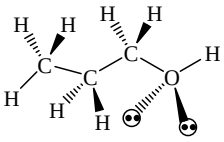
prefix: #-hydroxy

Condensed line formula

RCH_2OH or HOH_2CR

RCHOHR'

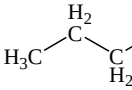
alcohol (3D)



IUPAC: propan-1-ol

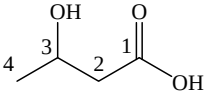
former: 1-propanol

common: n-propyl alcohol



(2D)

prefix example



3-hydroxybutanoic acid

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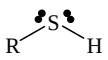
10. thiol (2D)



suffix: -#-thiol
(don't drop the final "e" of the stem name)

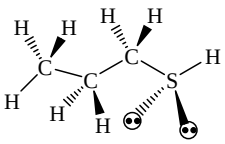
prefix: #-mercapto
#-sulfanyl

Condensed line formula

R_1CH_2SH or HSH_2CR_1

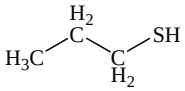
R_1CHSHR_2

thiol (3D)



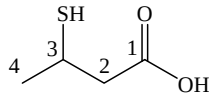
IUPAC: propan-1-thiol

common: propyl mercaptan



(2D)

prefix example



3-mercaptobutanoic acid

3-sulfanylbutanoic acid

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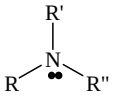
11. amines (1^o,2^o,3^o) (2D)



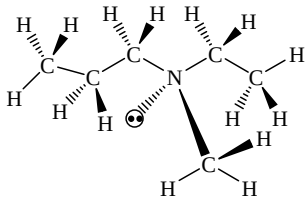
when highest priority functional group
1^o amines: suffix: -amine
2^o amines: prefix: N-alkyl suffix: -amine
3^o amines: prefix: N-alkyl-N-alkyl suffix: -amine

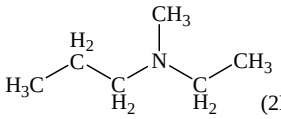
prefix when lower priority functional group:
1^o amines: prefix: #-amino
2^o amines: prefix: #-(N-alkylamino)
3^o amines: prefix: #-(N-allkyl-N-alkylamino)

Condensed line formula

RNH_2 H_2NR
$R(NR')R''$
$RCH(NH_2)R'$

3^o amine (3D)



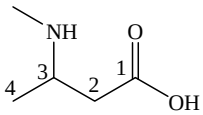


(2D)

IUPAC: N-ethyl-N-methylpropan-1-amine

former: ethylmethylpropylamine

prefix example



3-(N-methylamino)butanoic acid

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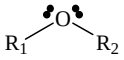
12. ether (2D)



suffix: none

prefix: #-alkoxy (< 5C)

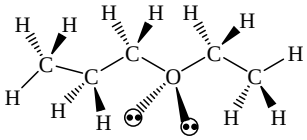
#-alkyloxy (≥ 5C)

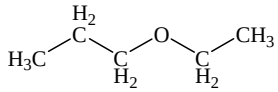
Condensed line formula

R_1OR_2

$R_1CH(OCH_3)R_2$

ether (3D)



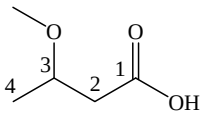


(2D)

IUPAC: 1-ethoxypropane

common: ethyl propyl ether

prefix example



3-methoxybutanoic acid

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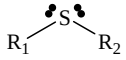
12. sulfide (2D)



suffix: none

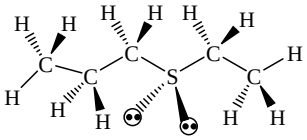
prefix: #-alkylthio

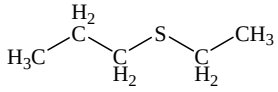
Condensed line formula

RSR'

$RCH(SCH_3)R'$

ether (3D)



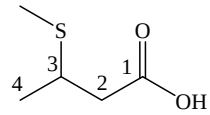


(2D)

IUPAC: 1-ethylthiopropane

former: ethyl propyl sulfide

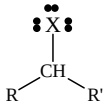
prefix example



3-methylthiobutanoic acid

---

12. haloalkane (2D)



X = -F = fluoro
X = Cl = chloro
X = Br = bromo
X = I = iodo

suffix: none

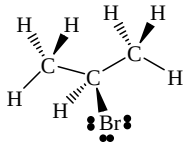
prefix: #-halo

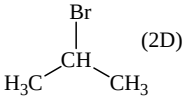
Condensed line formula

RCH_2Cl or ClH_2CR

RCHClR'

bromoalkane (3D)



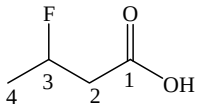


(2D)

IUPAC: 2-bromopropane

common: isopropyl bromide

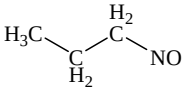
prefix example



3-fluorobutanoic acid

---

12. nitroso (2D)



suffix: none

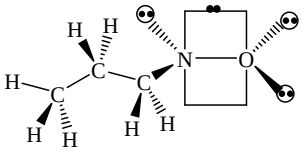
prefix: #-nitroso

Condensed line formula

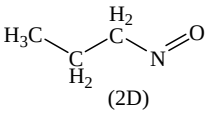
R_1CH_2NO or ONH_2CR

RCH(NO)R'

nitroso (3D)

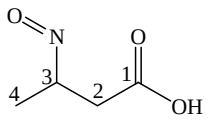


IUPAC: 1-nitrosopropane



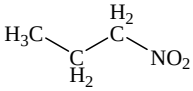
(2D)

prefix example



3-nitrosobutanoic acid

12. nitro (2D)



suffix: none

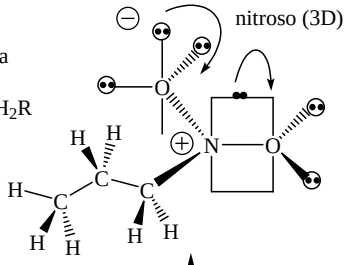
prefix: #-nitro

Condensed line formula

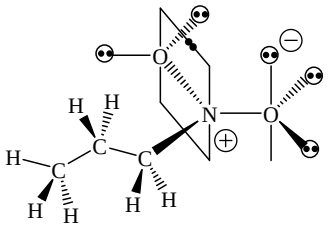
RCH_2NO_2 or O_2NCH_2R

$RCH(NO_2)R'$

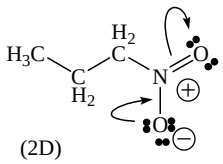
nitroso (3D)



resonance

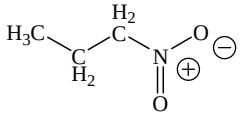


IUPAC: 1-nitropropane

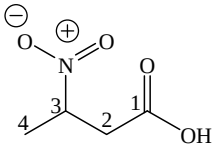


(2D)

resonance

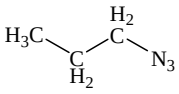


prefix example



3-nitrobutanoic acid

12. azides (2D)



suffix: none

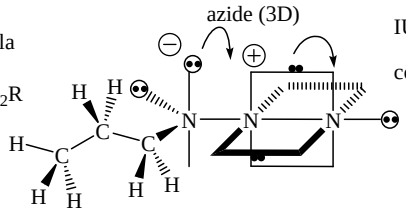
prefix: #-azido

Condensed line formula

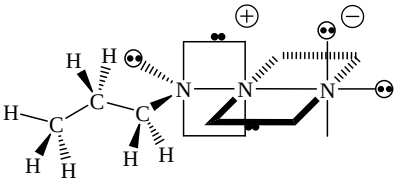
RCH_2N_3 or N_3CH_2R

$RCHN_3R'$

azide (3D)

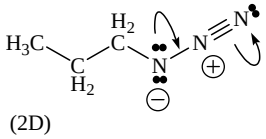


resonance



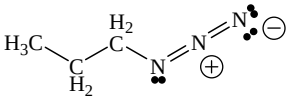
IUPAC: 1-azidopropane

common: propyl azide

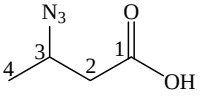


(2D)

resonance

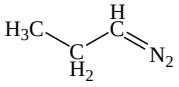


prefix example



3-azidobutanoic acid

12. diazo (2D)



suffix: none

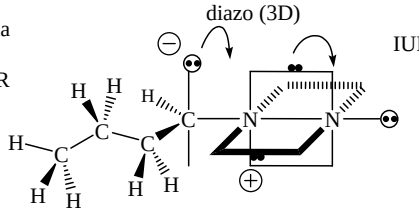
prefix: #-diazo

Condensed line formula

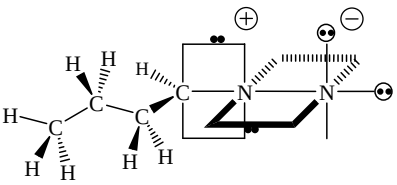
$RCHN_2$ or N_2CHR

$RCH(N_2)R'$

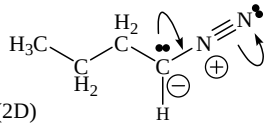
diazo (3D)



resonance

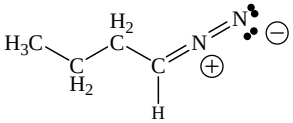


IUPAC: 1-diazobutane

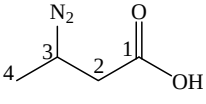


(2D)

resonance

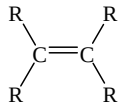


prefix example



3-diazobutanoic acid

alkenes (always a suffix on the stem name)

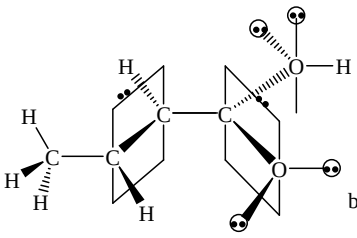


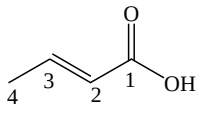
suffix: #-ene

prefix: none

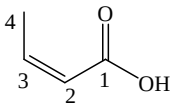
IUPAC: 2-methylpropene

common: isobutylene





but-2E-enoic acid



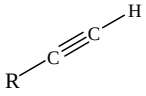
but-2Z-enoic acid

E = high priority opposite side

Z = high priority same side

---

alkynes (always a suffix on the stem name)

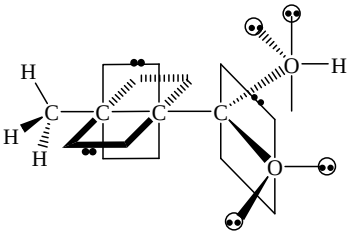


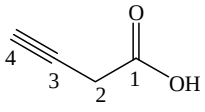
suffix: #-ene

prefix: none

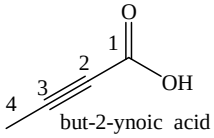
IUPAC: ethyne

common: acetylene





but-3-ynoic acid

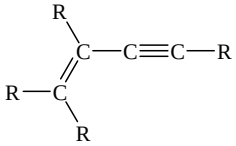


but-2-ynoic acid

E/Z is not possible

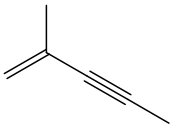
---

alkenes and alkynes (always a suffix on the stem name, -#-en-#-yne)

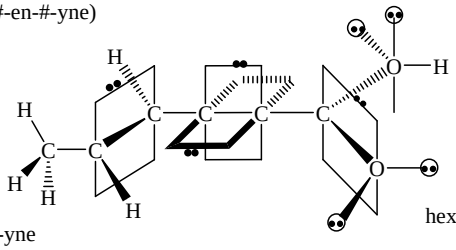


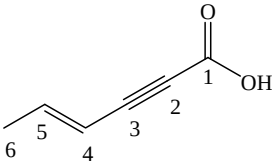
suffix: #-en-#-yne

prefix: none



IUPAC: 2-methylpent-1-en-3-yne





hex-4E-en-2-ynoic acid

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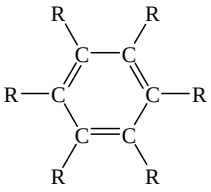
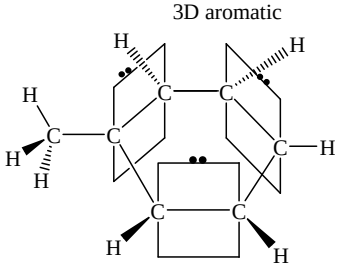
aromatics (2D)



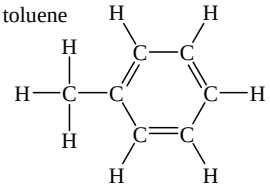
many special names

3D aromatic

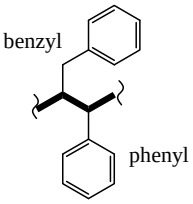


IUPAC: methylbenzene

common: toluene



branches

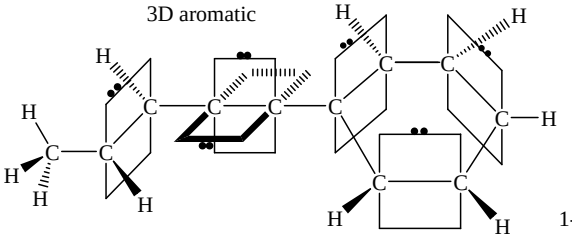


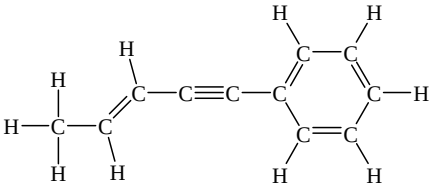
benzyl

phenyl

(2D)

3D aromatic





1-phenylpent-3E-en-1-yne

---

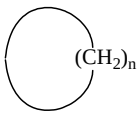
alkanes

CH_4 = methane (1C)

$H_3C-(CH_2)_n-CH_3$

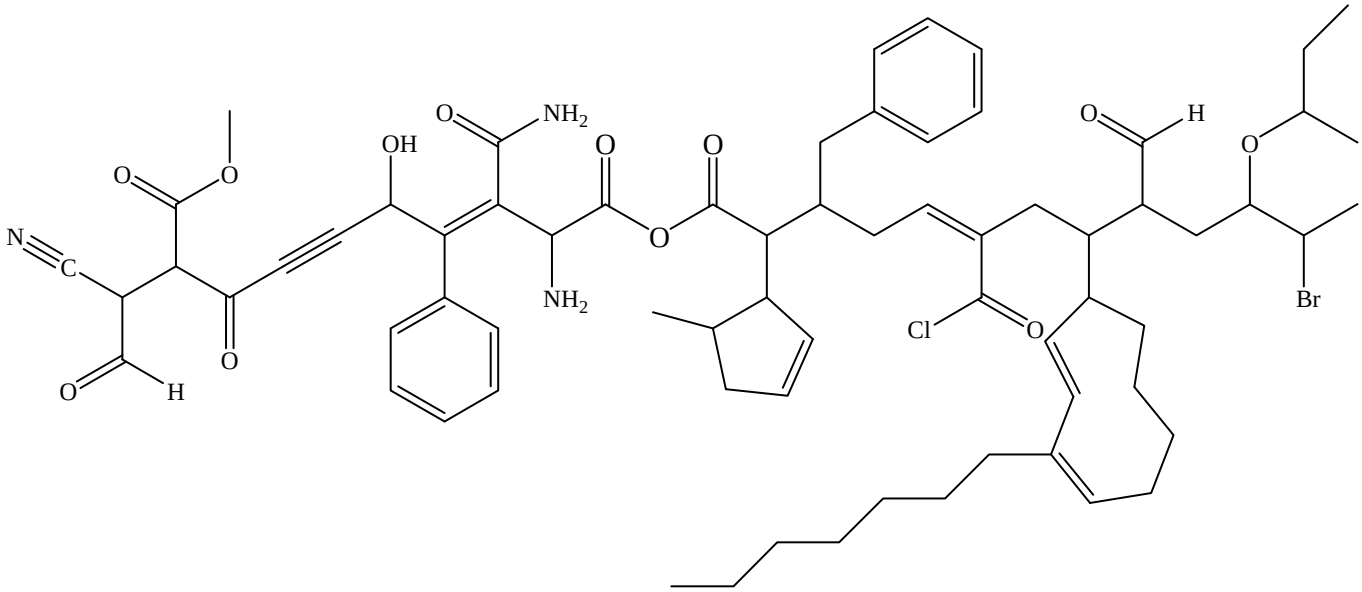
n = 0 = ethane (2C)
n = 1 = propane (3C)
n = 2 = butane (4C)
n = 3 = pentane (5C)
n = 4 = hexane (6C)
n = 5 = heptane (7C)
n = 6 = octane (8C)
n = 7 = nonane (9C)
n = 8 = decane (10C)
n = 9 = undecane (11C)
n = 10 = dodecane (12C)
n = 11 = tridecane (13C)
n = 12 = tetradecane (14C)
n = 13 = pentadecane (15C)

cycloalkanes

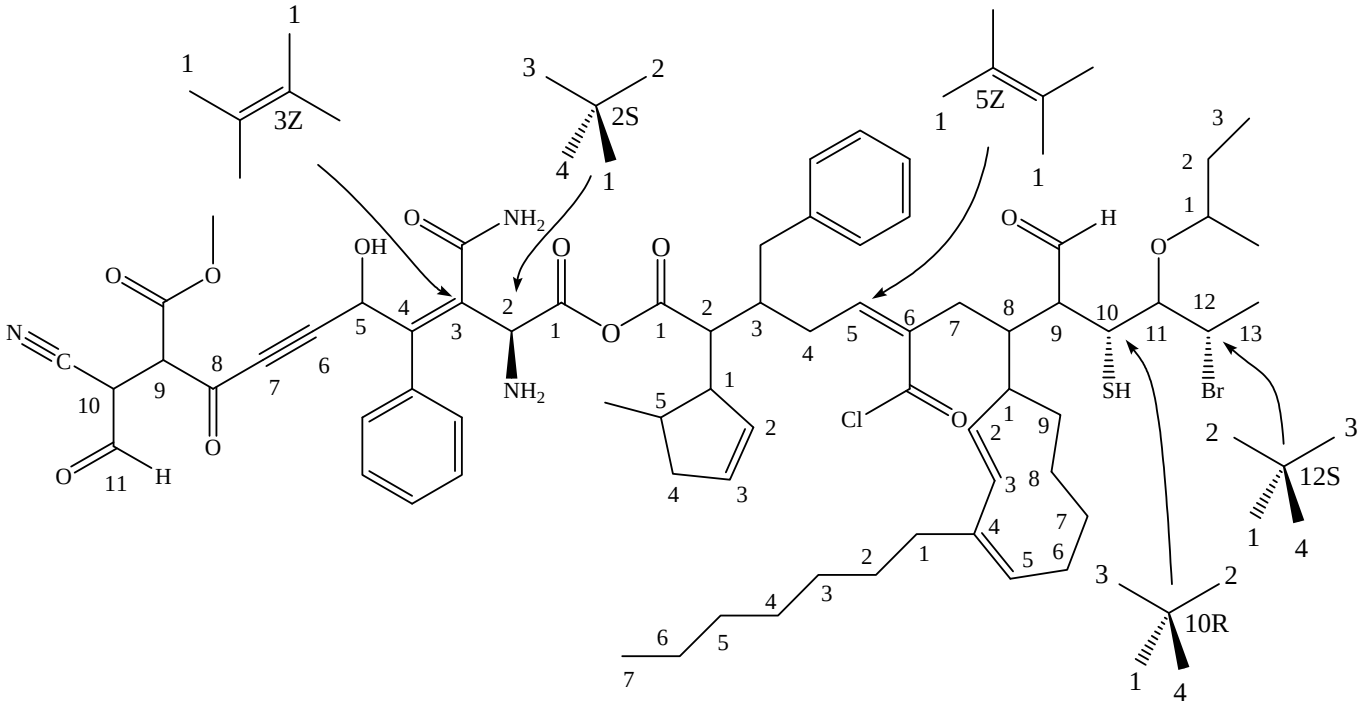


n = 3 = cyclopropane
n = 4 = cyclobutane
n = 5 = cyclopentane
n = 6 = cyclohexane
n = 7 = cycloheptane
n = 8 = cyclooctane
n = 9 = cyclononane
n = 10 = cyclodecane
n = 11 = cycloundecane
n = 12 = cyclododecane
n = 13 = cyclotridecane
n = 14 = cyclotetradecane

Functional Group Combinations



Possible answer (each side is a separate word because this is an anhydride = 2 x “-oic” + anhydride)

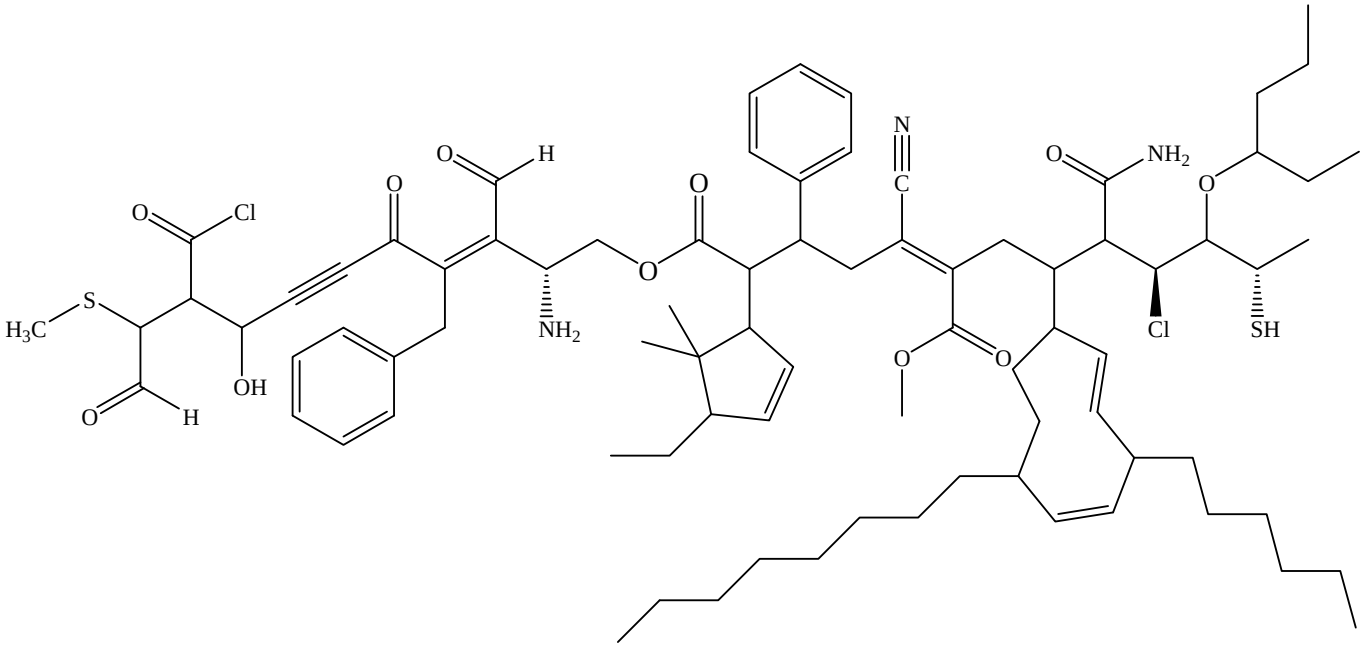


2S-amino-3-amido-4-phenyl-5-hydroxy-8,11-dioxo-9-methoxycarbonyl-10-cyanoundec-3Z-en-6-ynoic

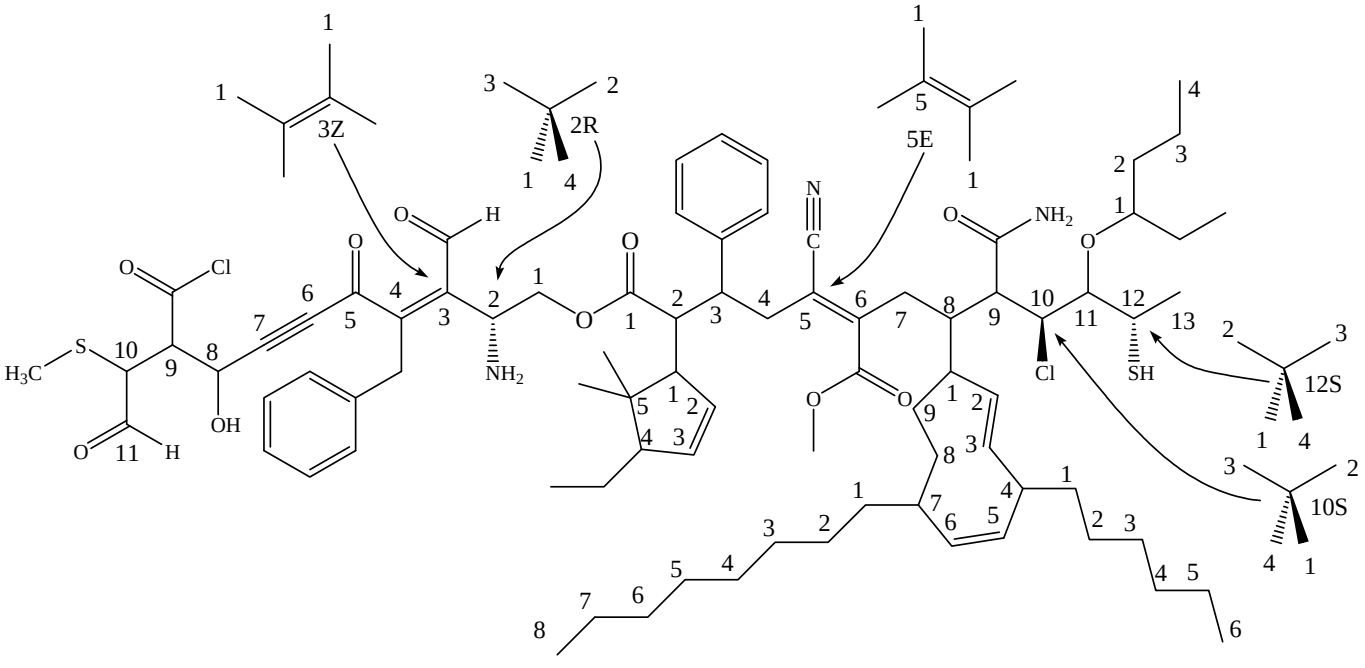
2-(5-methylcyclopent-2-enyl)-3-benzyl-6-chlorocarbonyl-8-(4-heptylcyclonona-2E,4Z-dienyl)-9-formyl-

10R-mercapto-11-(1-methylpropoxy)-12S-bromotridec-5Z-enoic anhydride

Functional Group Combination



Possible answer (each side is a separate word, the first word is the name of the “alkyl” branch attached to the ester oxygen on the left side and the second part is the name of the branch with the carbonyl group on the right side).



(space)

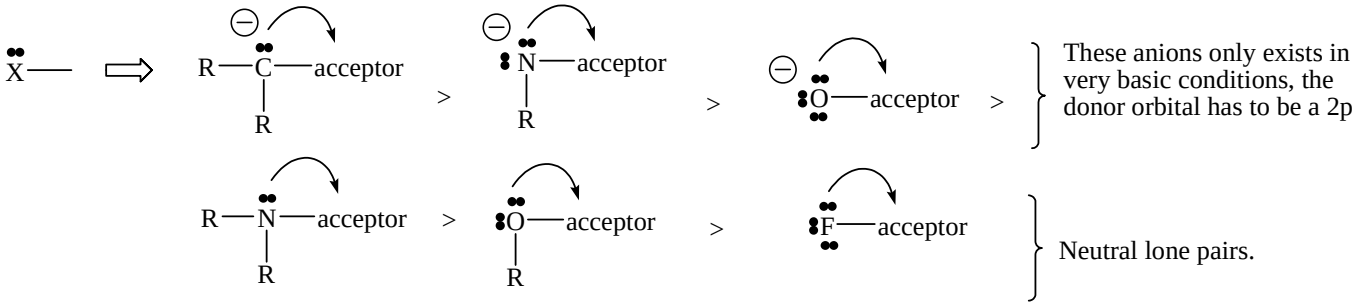
2R-amino-3-formyl-4-benzyl-5,11-dioxo-8-hydroxy-9-chlorocarbonyl-10-methylthioundec-3Z-en-6-ynyl

2-(4-ethyl-5,5-dimethylcyclopent-2-enyl)3-phenyl-5-cyano-6-methoxycarbonyl-8-(4-hexyl-7-octylcyclonona-2E,5Z-dienyl)-9-amido-10S-chloro-11-(1-ethylbutoxy)-12S-mercaptotridec-5E-enoate

Common Resonance Patterns

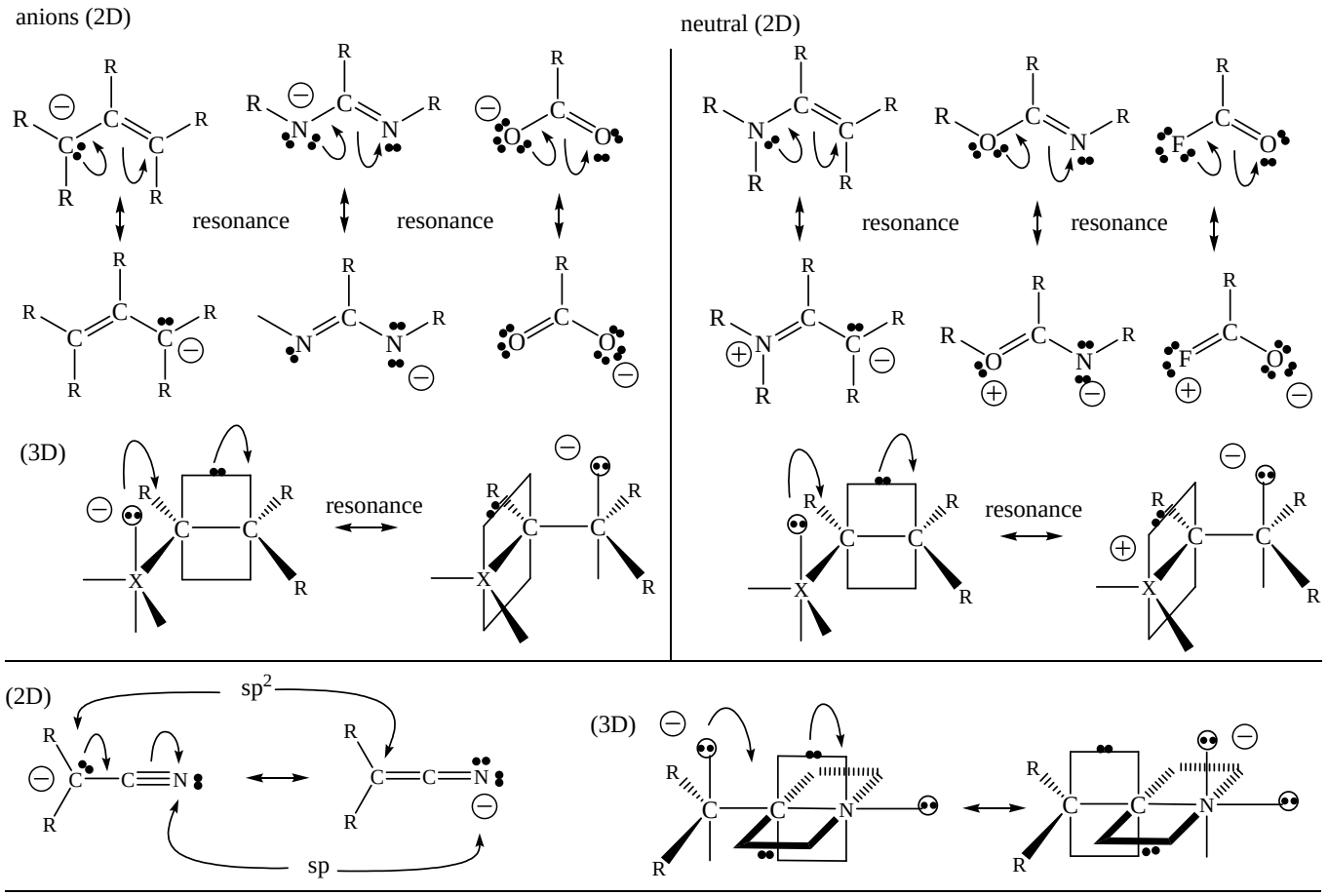
There are 2 types of donors: a. lone pair electrons and b. carbon-carbon pi bonds (alkenes, alkynes and aromatic rings). There are 2 types of acceptors: empty carbon 2p orbitals (carbocations) and pi bonds of all types.

1. Lone pair electron pair donors (acceptors sites are empty carbon 2p orbitals (carbocations) and other pi bonds

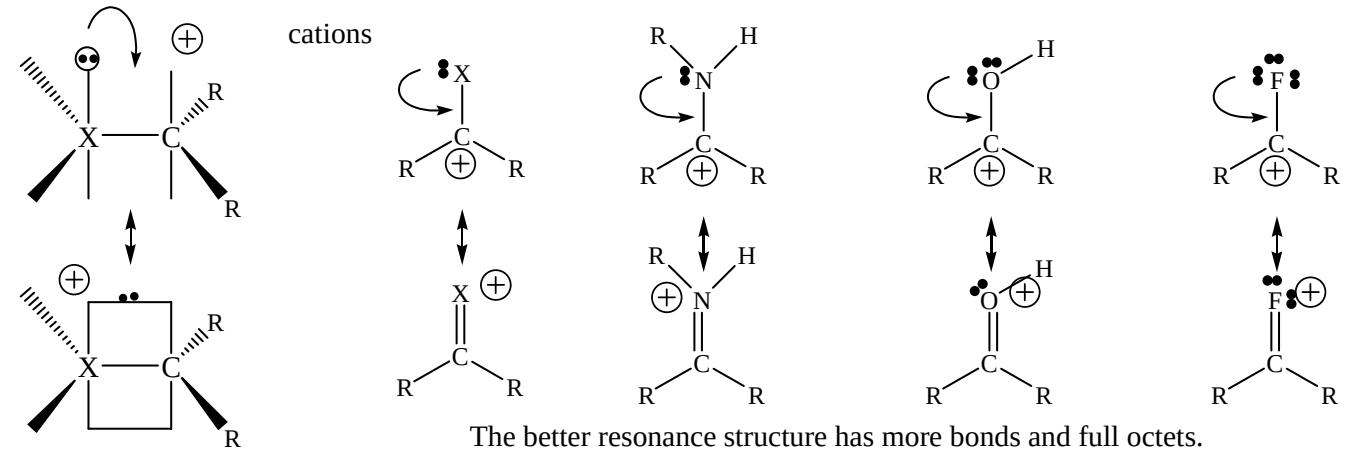


acceptors = empty carbon 2p orbitals and any kind of pi bond

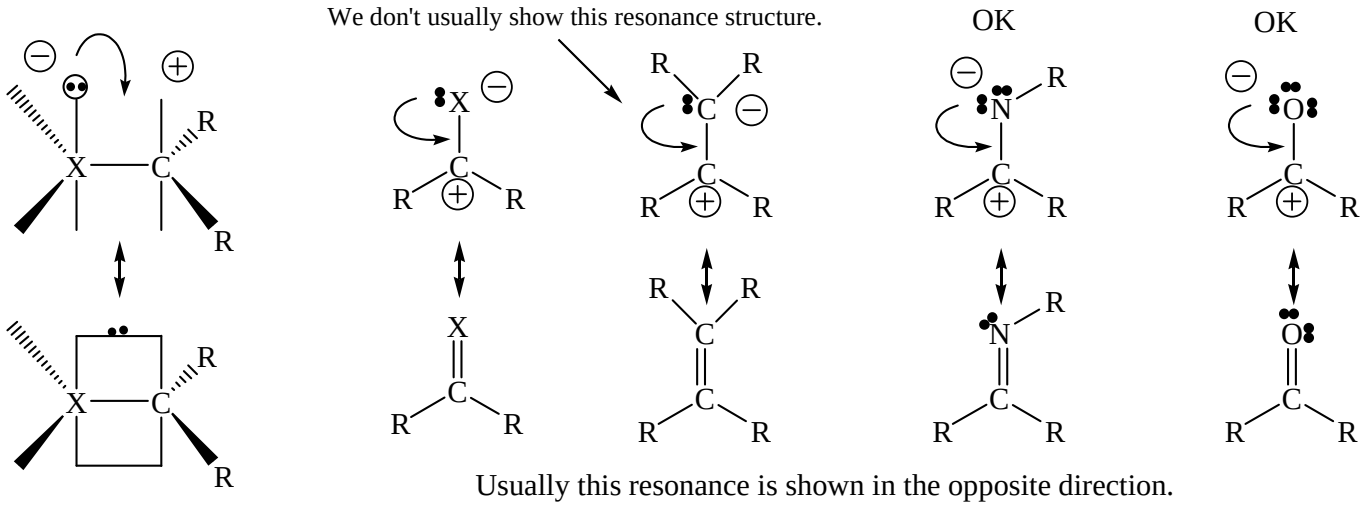
2. Lone pair donation into pi bonds – lone pairs can be anions or neutral, there are many variations. The pi bond acceptors below can be C=C, C≡C, C=O, C=N, C≡N and N=O and more. The more electronegative the pi bond is, the better pi acceptor it is.



3. Lone pair donation (donor atoms: N > O > F) into an empty carbon 2p orbital (usually a sp^2 carbocation and that's all we'll show)



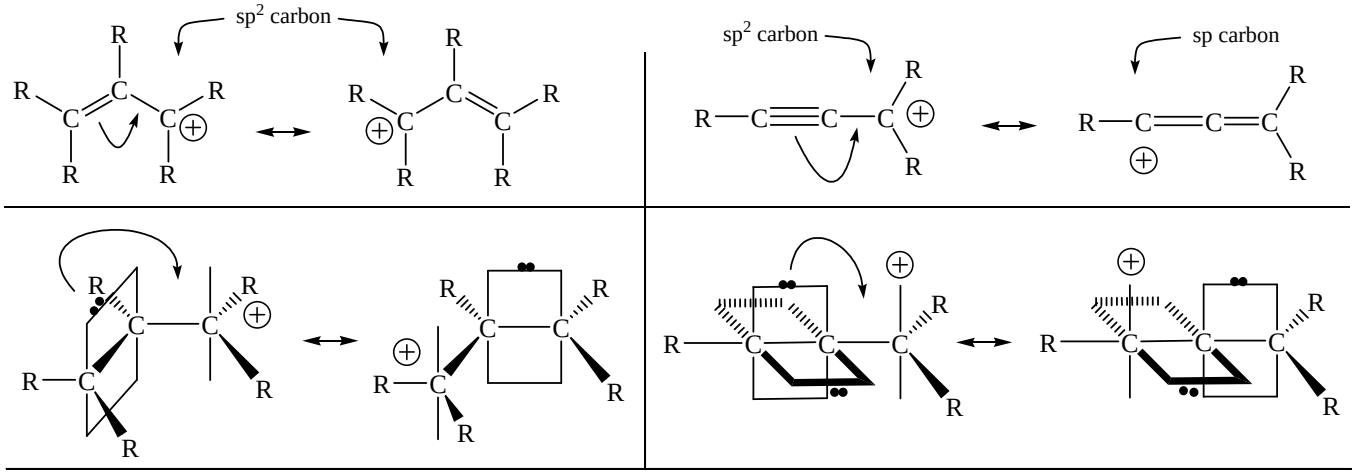
The better resonance structure has more bonds and full octets.



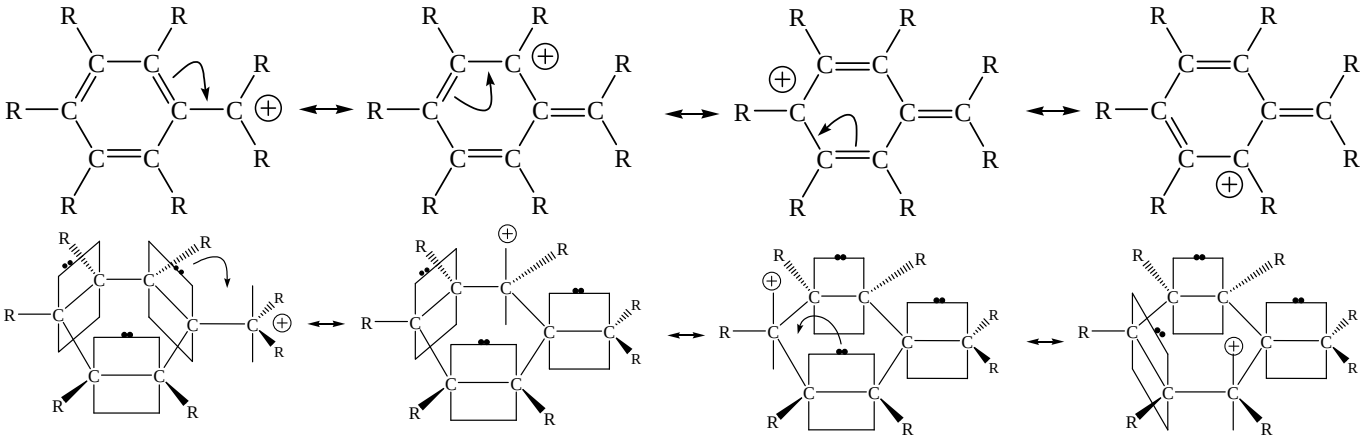
Usually this resonance is shown in the opposite direction.

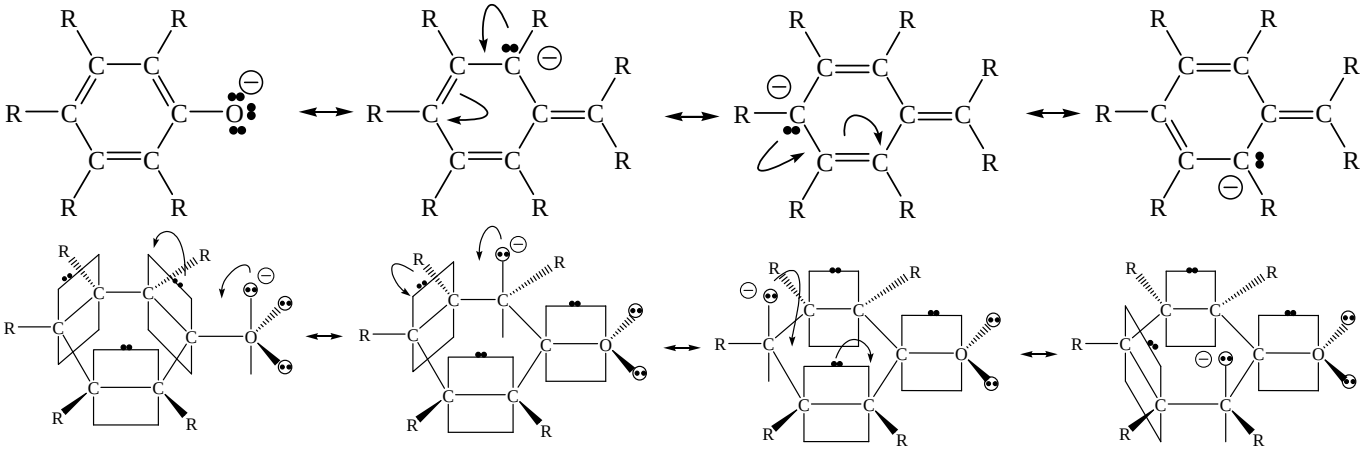
4. Only carbon-carbon pi bonds can act as pi donors (alkenes, alkynes and aromatics) into carbon empty 2p orbitals or other acceptor pi bonds of many types (C=C, C≡C, C=O, C=N, C≡N, N=O and more.).

Carbon-carbon pi bond donation into an empty carbon 2p orbital (usually an sp^2 carbocation)

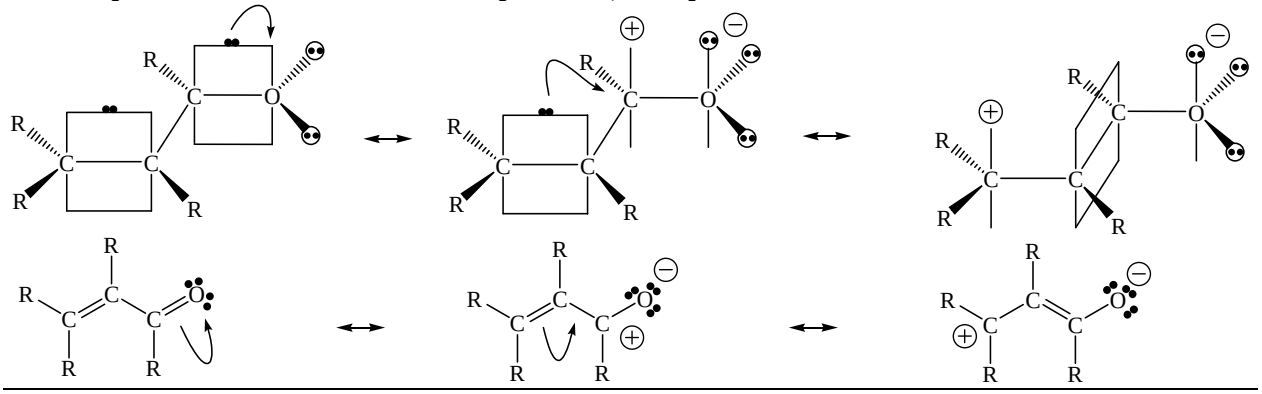


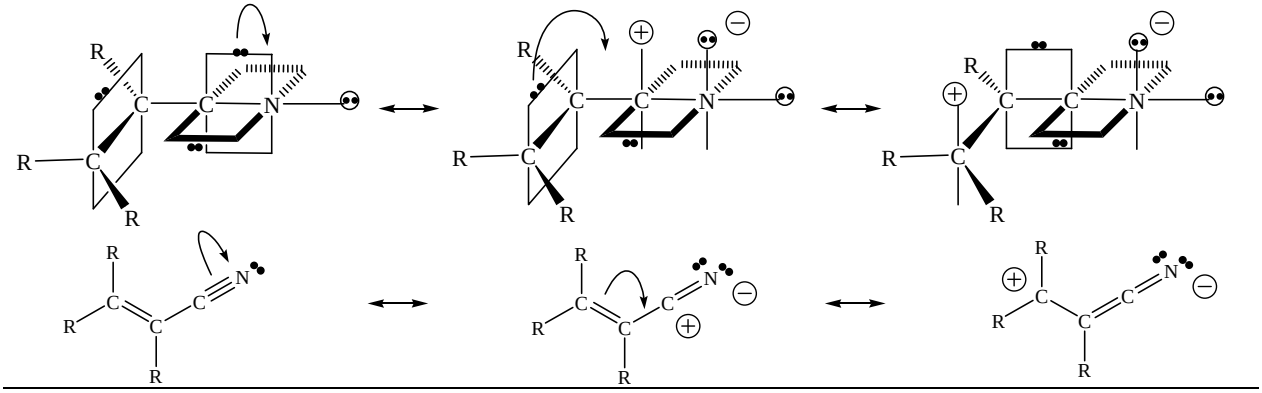
Aromatic rings can donate or accept electron density from substituent positions (example of each below).

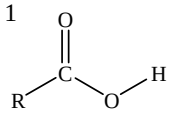
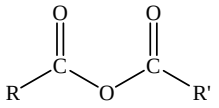
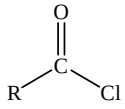
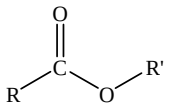
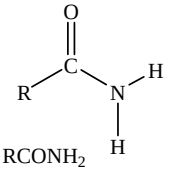
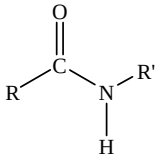
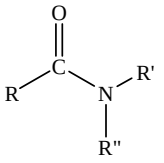
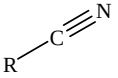
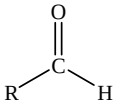
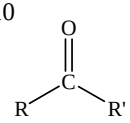
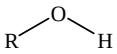
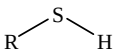
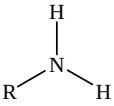
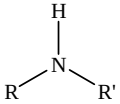
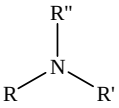
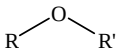
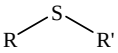
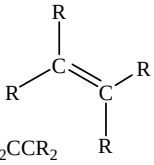
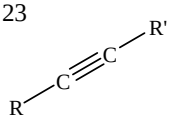
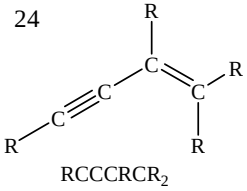
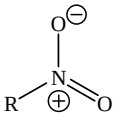
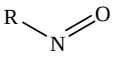
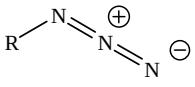
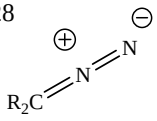
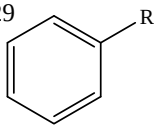




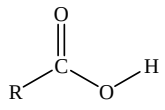
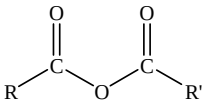
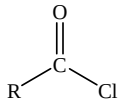
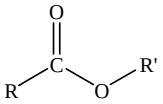
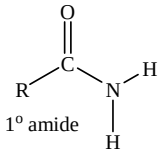
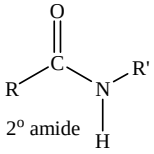
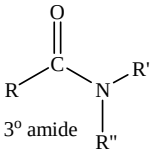
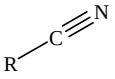
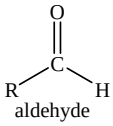
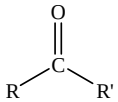
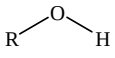
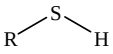
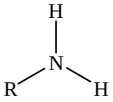
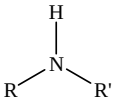
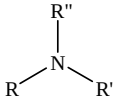
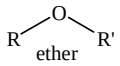
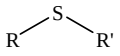
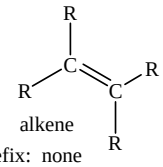
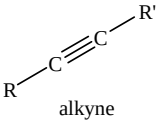
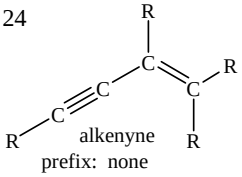
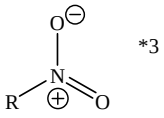
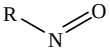
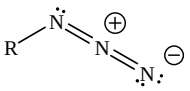
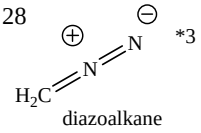
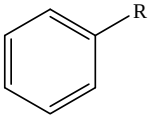
Carbon-carbon pi bond donation into another pi bond (more polar is better, but even C=C is ok.



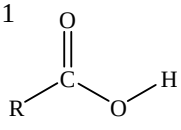
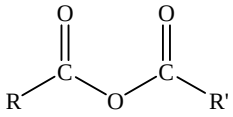
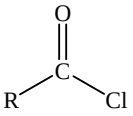
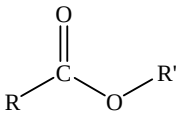
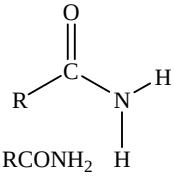
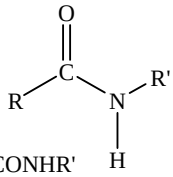
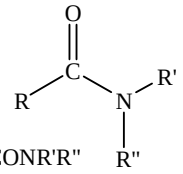
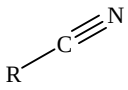
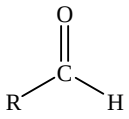
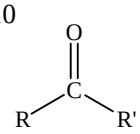
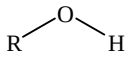
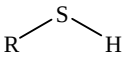
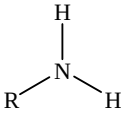
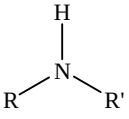
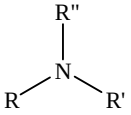
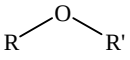
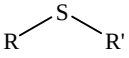
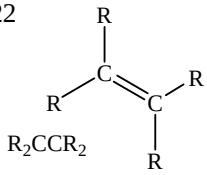
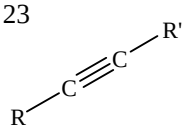
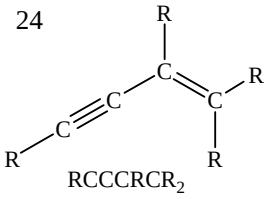
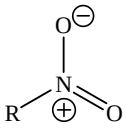
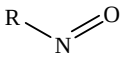
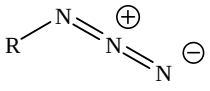
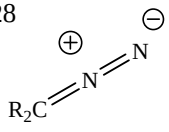
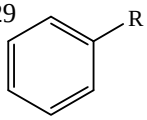


1  RCO_2H	2  RCO_2COR	3  RCOCl	4  RCO_2R'	5  $RCONH_2$
6  RCONHR'	7  RCONR'R" (R ≠ R' ≠ R")  (R' = R")	8  RCN	9  RCHO	10  RCOR'
11  ROH	12  RSH	13  RNH_2	14  RNHR'	15  RNR'R"
16  ROR'	17  RSR'	18  RBr	19  RCl	20  RF
21  RI	22  R_2CCR_2	23  RCCR'	24  $RCCCRCR_2$	25  RNO_2
26  RNO	27  RN_3	28  R_2CN_2	29  RC_6H_5	30  RH

a. aromatic
b. fluoro
c. carboxylic acid
d. 1° amine
e. 2° amide
f. nitrile
g. thiol
h. ether
i. bromo
j. acid chloride
k. ketone
l. sulfide
m. alkane
n. nitro
o. 3° amide
p. alkene
q. aldehyde
r. nitroso
s. alcohol
t. iodo
u. 2° amine
v. alkyne
w. chloro
x. 3° amine
y. azido
z. anhydride
aa. 1° amide
bb. diazo
cc. ester
dd. alkene/alkyne

1  carboxylic acid prefix: #-carboxy[*1] suffix: -oic acid	2  anhydride prefix: #-acyloxyalkylcarbonyl[*2] suffix: -oic anhydride (R = R') -oic -oic anhydride (R ≠ R')	3  acid chloride prefix: #-chlorocarbonyl suffix: -oyl chloride	4  ester prefix: #-alkoxycarbonyl suffix: -oate (R' name as branch at front)	5  1° amide prefix: #-amido or #-carbamoyl suffix: -amide
6  2° amide prefix: #-(N-alkylamido) #-(N-alkylcarbamoyl) suffix: -amide name R' as N-alkyl in front	7  3° amide prefix: #-(N-alkyl-N-alkylamido) #-(N-alkyl-N-alkylcarbamoyl) suffix: -amide name R',R" as N-alkyl-N-alkyl in front	8  nitrile prefix: #-cyano suffix: -nitrile	9  aldehyde prefix: #-oxo- (in chain) or #-formyl (as branch) suffix: #-al	10  ketone prefix: #-oxo suffix: -#-one
11  alcohol prefix: #-hydroxy suffix: -#-ol	12  thiol prefix: #-mercapto or #-sulfanyl suffix: -#-thiol	13  1° amine prefix: #-amino suffix: -#-amine	14  2° amine prefix: #-(N-alkylamino) suffix: -#-amine	15  3° amine prefix: #-(N-alkyl-N-alkylamino)- suffix: -#-amine
16  ether prefix: #-alkoxy (≤ 5C) #-alkyloxy (> 5C) suffix: none	17  sulfide prefix: #-alkylthio suffix: none	18  bromoalkane prefix: #-bromo suffix: none	19  chloroalkane prefix: #-chloro suffix: none	20  fluoroalkane prefix: #-fluoro suffix: none
21  iodoalkane prefix: #-iodo suffix: none	22  alkene prefix: none suffix: -#-ene	23  alkyne prefix: none suffix: -#-yne	24  alkenyne prefix: none suffix: -#-en-#-yne	25  *3 nitroalkane prefix: #-nitro suffix: none
26  nitrosoalkane prefix: #-nitroso suffix: none	27  *3 azidoalkane prefix: #-azido suffix: none	28  *3 diazoalkane prefix: #-diazo suffix: none	29  aromatic many special names	30  alkane prefix: #-alkyl suffix: -ane

*1: not used because we don't use any higher priority group
*2: not used because it is too complicated for our level
*3: formal charge and resonance

1  RCO_2H carboxylic acid	2  RCO_2COR anhydride	3  RCOCl acid chloride	4  RCO_2R' ester	5  $RCONH_2$ 1^o amide
6  RCONHR' 2^o amide	7  RCONR'R" 3^o amide	8  RCN nitrile	9  RCHO aldehyde	10  RCOR' ketone
11  ROH alcohol	12  RSH thiol	13  RNH_2 1^o amine	14  RNHR' 2^o amine	15  RNR'R" 3^o amine
16  ROR' ether	17  RSR' sulfide	18  RBr bromoalkane	19  RCl chloroalkane	20  RF fluoroalkane
21  RI iodoalkane	22  R_2CCR_2 alkene	23  RCCR' alkyne	24  $RCCCRCR_2$ alkenyne	25  RNO_2 nitroalkane
26  RNO nitrosoalkane	27  RN_3 azidoalkane	28  R_2CN_2 diazoalkane	29  RC_6H_5 aromatic	30  RH alkane