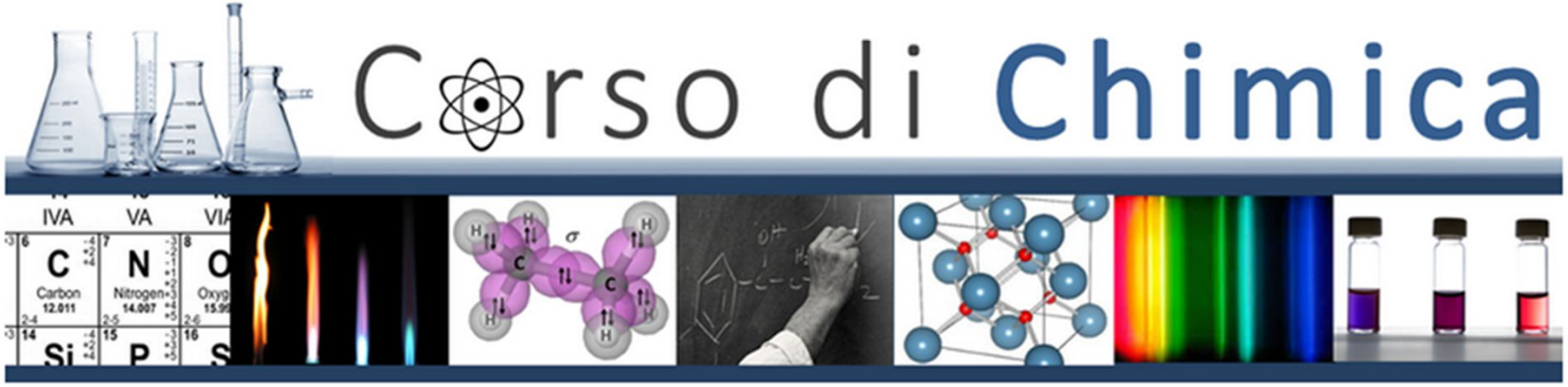
UNIVERSITÀ
DEGLI STUDI DI TRIESTE

Dipartimento di Ingegneria ed Architettura



docente
Alois Bonifacio
(abonifacio@units.it)

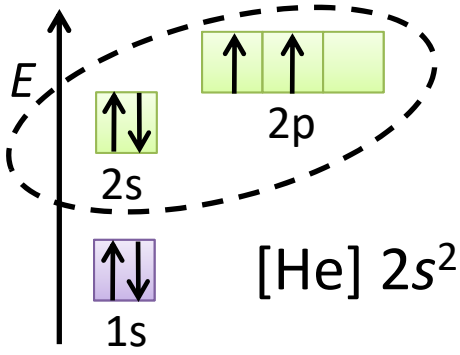
il legame chimico nei composti del carbonio

i legami nei composti del carbonio

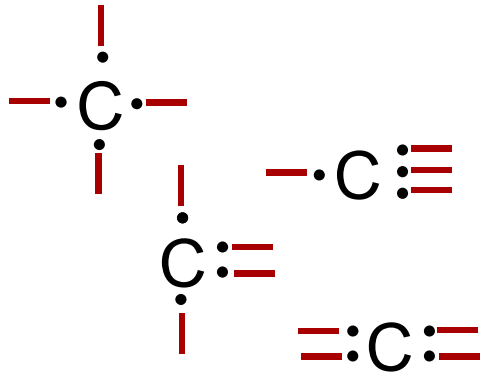
6
C
Carbon
12.01

caratteristiche uniche

1. struttura elettronica con **4 elettroni di valenza** (tetravalenza) con possibilità di legami doppi e tripli



[He] $2s^2 2p^2$

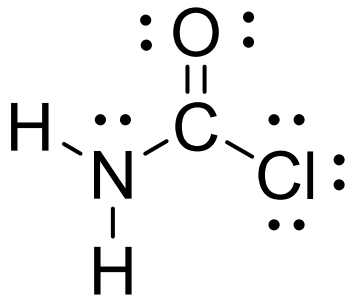


i legami nei composti del carbonio

6
C
Carbon
12.01

caratteristiche uniche

2. **elettronegatività intermedia** (χ=2.5), forma legami covalenti con elementi quali H, O, N ed alogeni



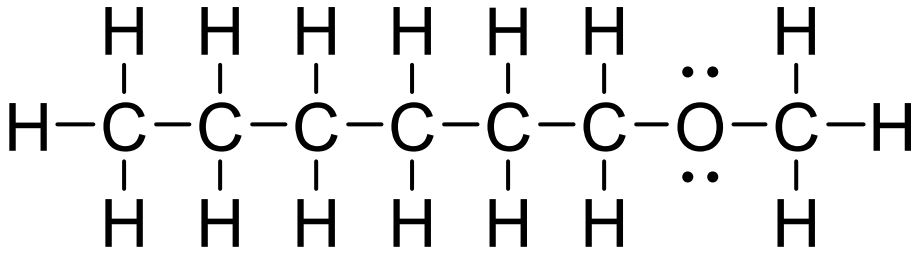
i legami nei composti del carbonio

6
C
Carbon
12.01

caratteristiche uniche

3. **legami molto stabili** che permettono la formazione di lunghe catene, ma allo stesso tempo non troppo forti da impedire una certa reattività chimica

C—C	346 kJ/mol
Si—Si	222 kJ/mol
C—O	358 kJ/mol
Si—O	452 kJ/mol

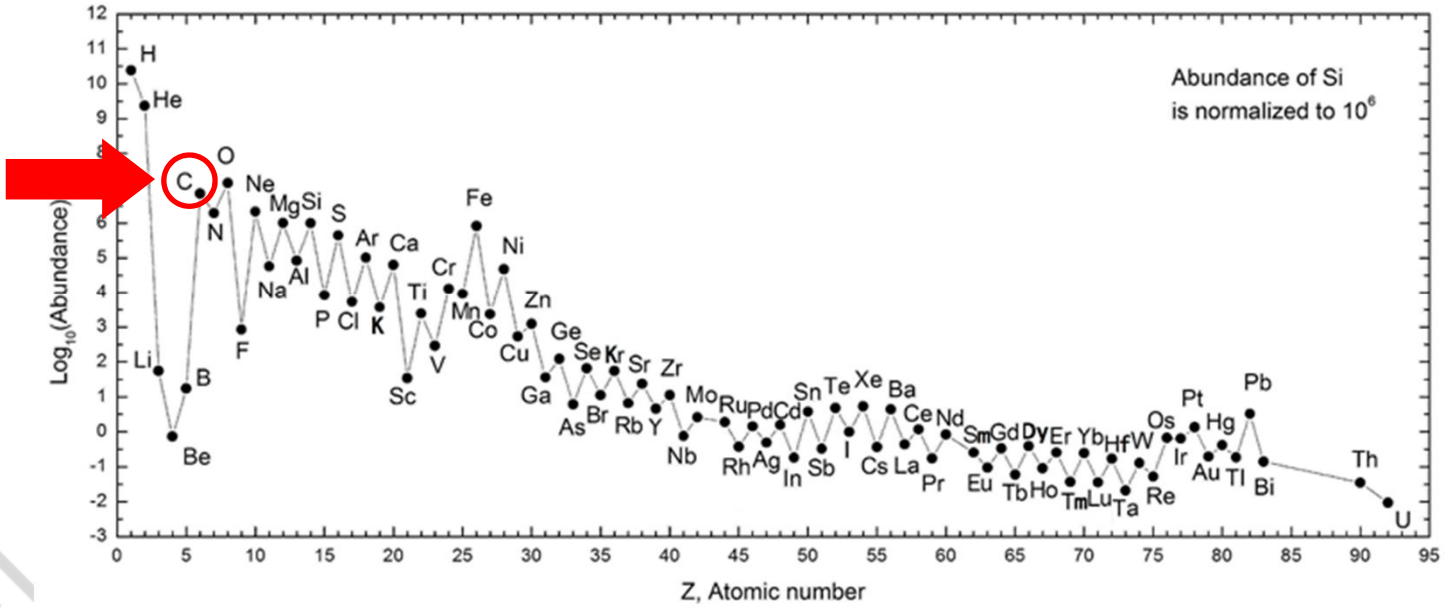


i legami nei composti del carbonio

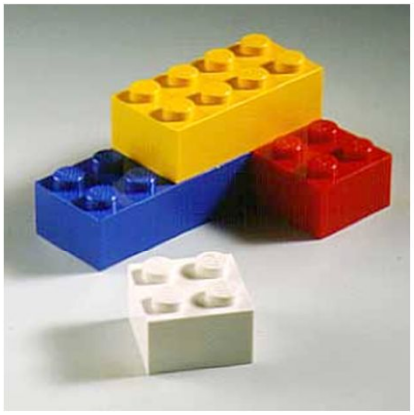
6
C
Carbon
12.01

caratteristiche uniche

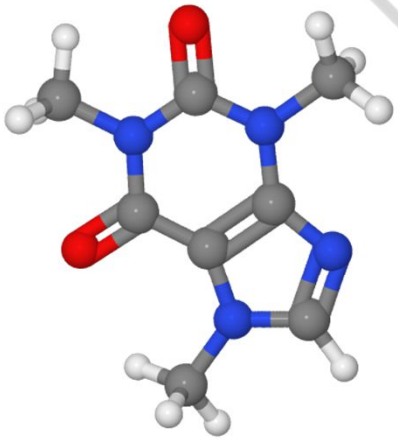
4. **abbondanza** (4° elemento più abbondante nell'universo)

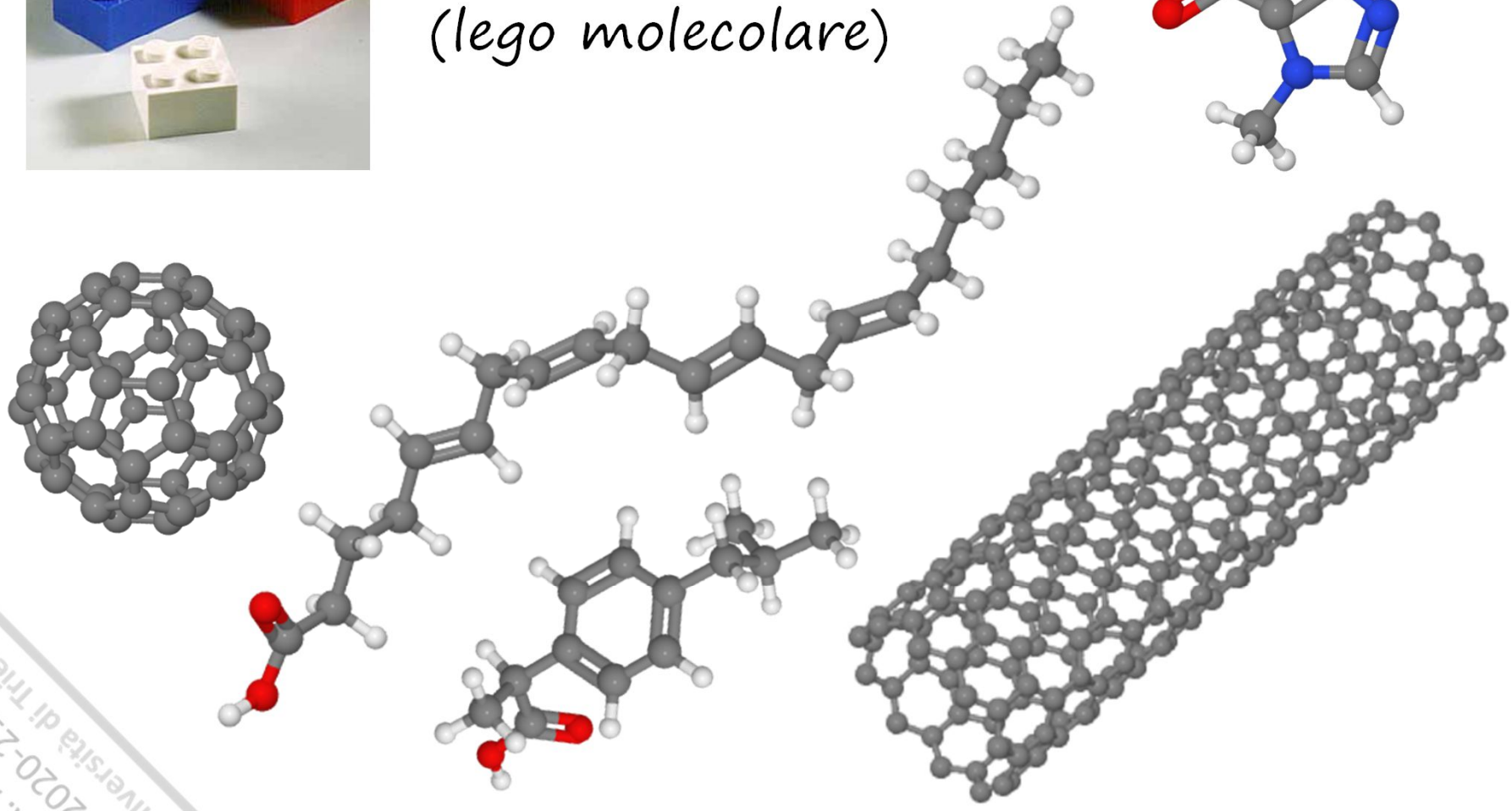


i legami nei composti del carbonio



ampia varietà strutturale
(lego molecolare)





idrocarburi

principali costituenti del petrolio

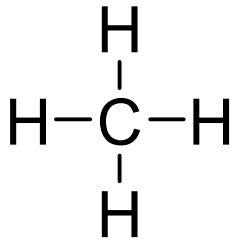
C_xH_y *composti di C e H*

(classificazione generale)

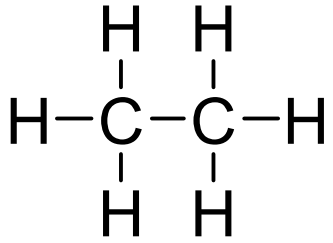
- idrocarburi
  - alifatici
    - saturi (alcani)
    - insaturi
      - alcheni
      - alchini
  - aromatici
    - benzenici
    - policiclici

alcani

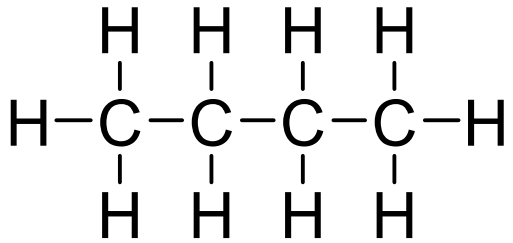
C_nH_{2n+2} *solo legami* ***singoli***



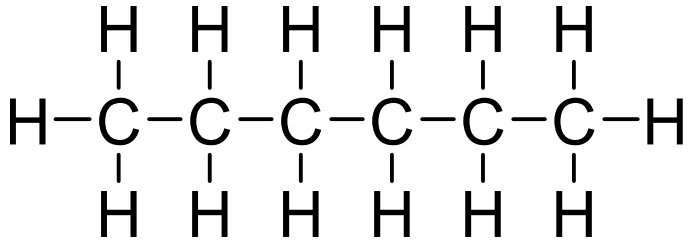
CH_4



C_2H_6



C_4H_{10}



C_6H_{14}

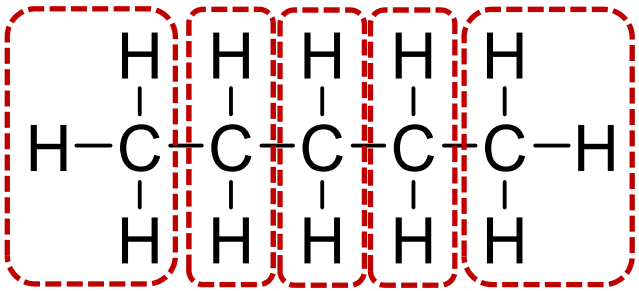
alcani

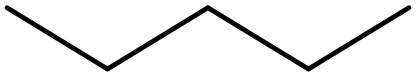
una formula, molte rappresentazioni

1) C_5H_{12}

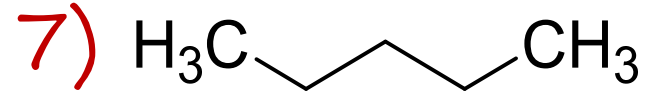
3) $CH_3CH_2CH_2CH_2CH_3$

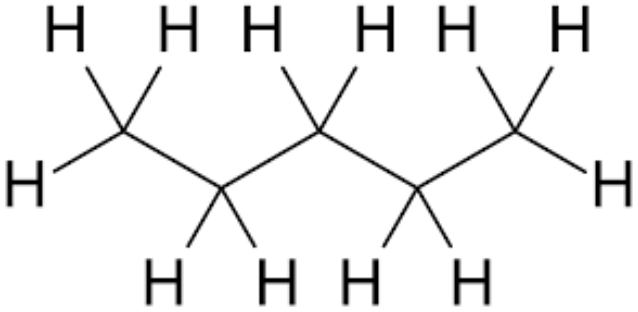
4) $CH_3(CH_2)_3CH_3$

2) 

5) 

(solo gli atomi di carbonio)

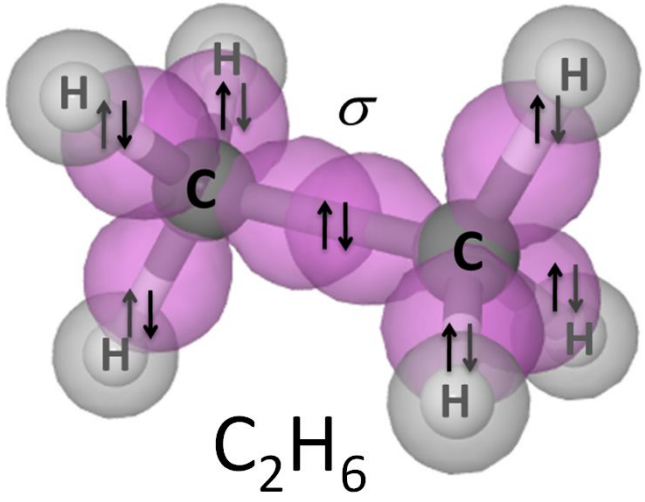
7) 

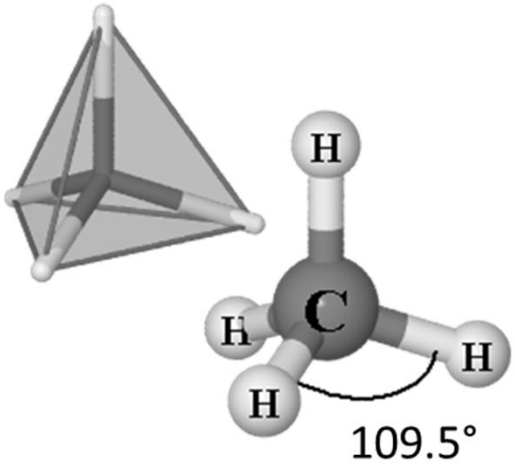
6) 

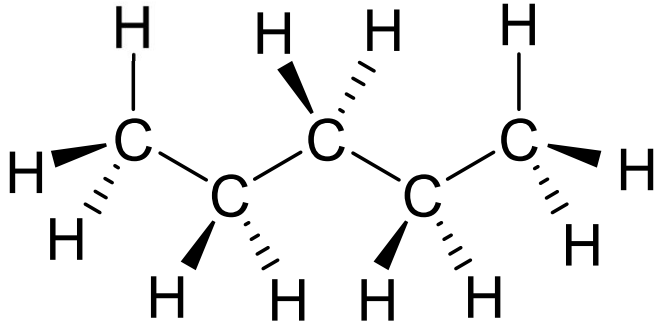
alcani

C_nH_{2n+2}

solo carbonio sp^3 (tetraedrico)







alcani

C_nH_{2n+2}

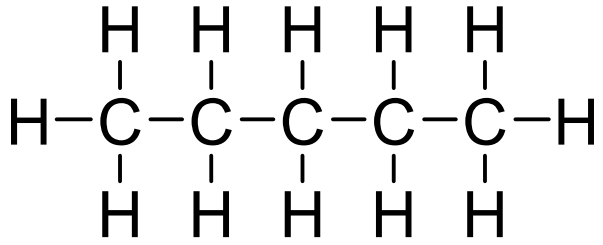
nomenclatura

(n° carboni) **-ano**

nome	n° atomi carbonio	formula	formula condensata
*met*ano	1	CH_4	CH_4
*et*ano	2	C_2H_6	CH_3CH_3
*prop*ano	3	C_3H_8	$CH_3CH_2CH_3$
*but*ano	4	C_4H_{10}	$CH_3CH_2CH_2CH_3$
*pent*ano	5	C_5H_{12}	$CH_3CH_2CH_2CH_2CH_3$
*es*ano	6	C_6H_{14}	$CH_3(CH_2)_4CH_3$
*ept*ano	7	C_7H_{16}	$CH_3(CH_2)_5CH_3$

alcani

C_nH_{2n+2}



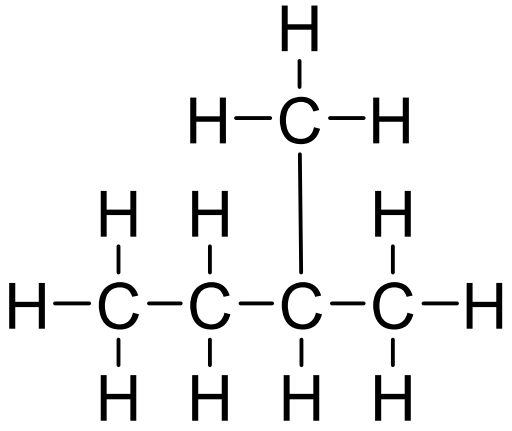
C_5H_{12}

pentano

(n-pentano)

alcani a catena **lineare**

?



C_5H_{12}

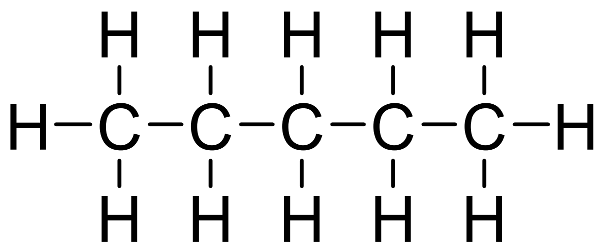
pentano

(iso-pentano)

alcani a catena **ramificata**

alcani

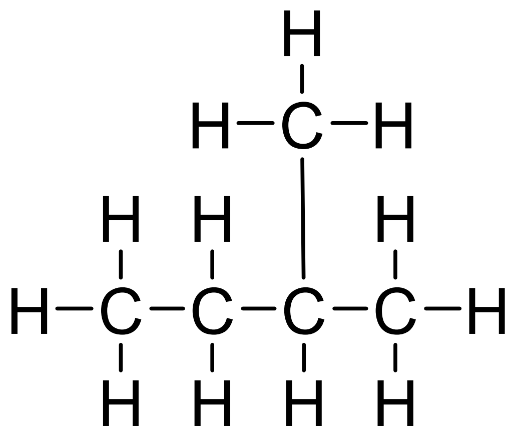
C_nH_{2n+2}



C_5H_{12}

n-pentano

$CH_3CH_2CH_2CH_2CH_3$



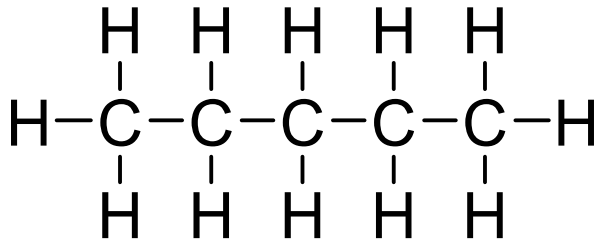
C_5H_{12}

iso-pentano

CH_3
|
$CH_3CH_2CHCH_3$

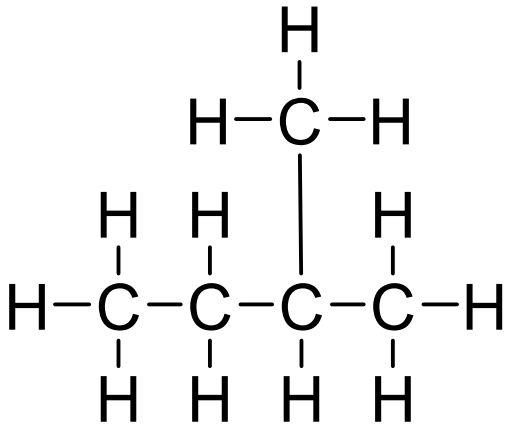
alcani

C_nH_{2n+2}



C_5H_{12}

n-pentano



C_5H_{12}

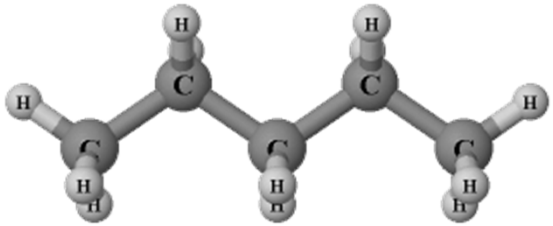
iso-pentano

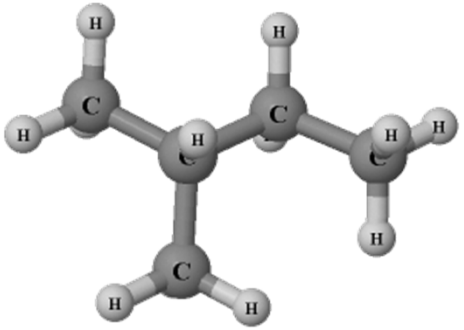
isomeri strutturali

stessa composizione
ma forma diversa

alcani

C_nH_{2n+2}





C_5H_{12} C_5H_{12}

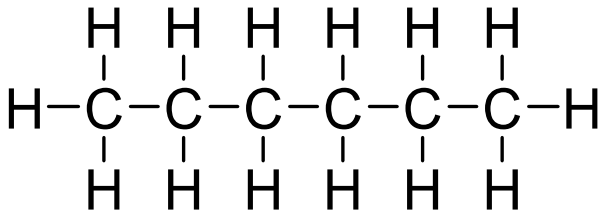
n-pentano *iso-pentano*

isomeri strutturali

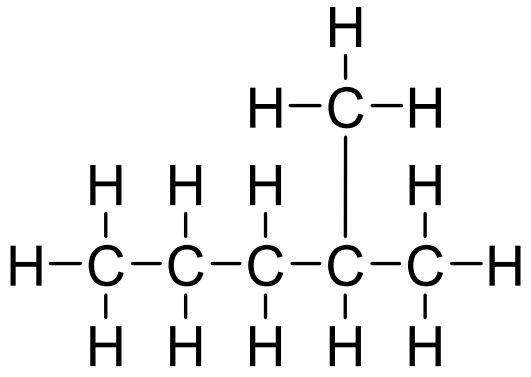
stessa composizione
ma forma diversa

alcani

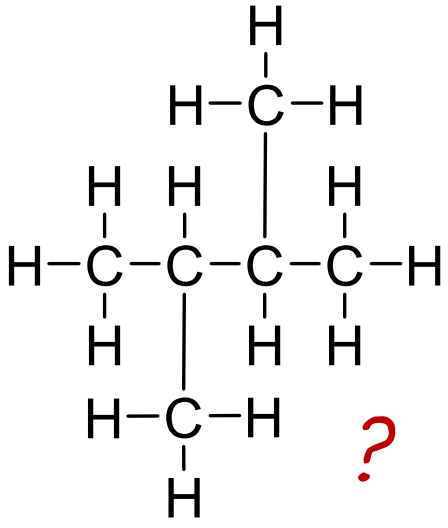
C_6H_{14}



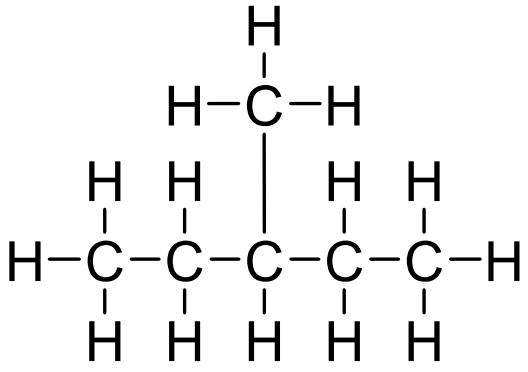
n-esano



iso-esano?



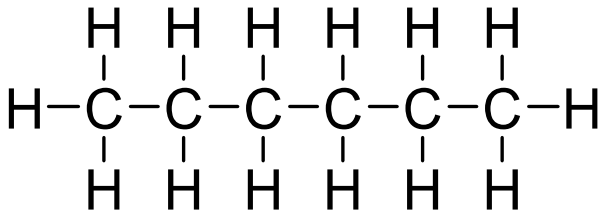
?



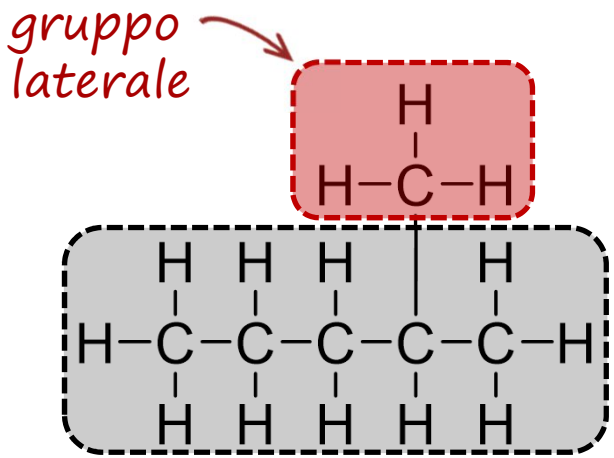
?

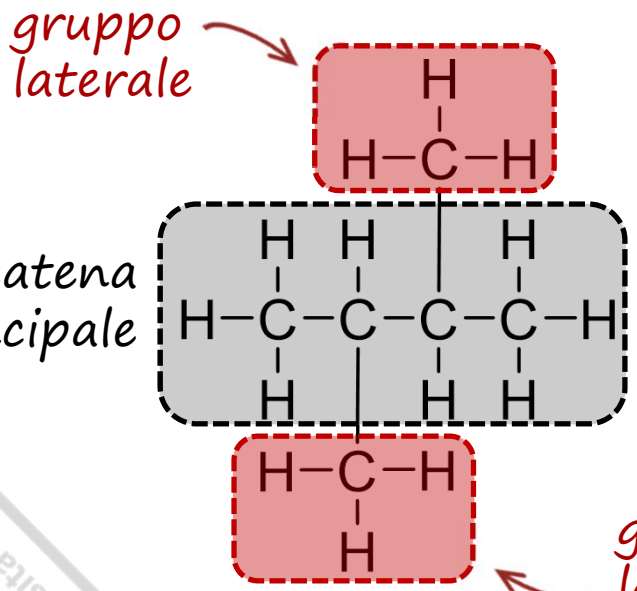
alcani

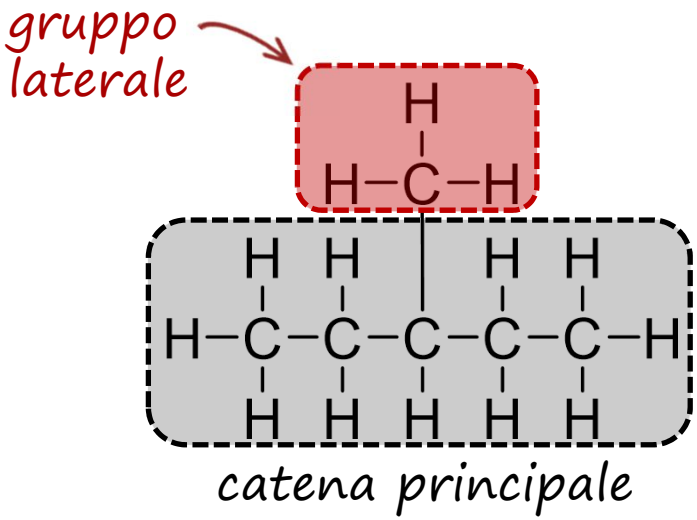
C_6H_{14}



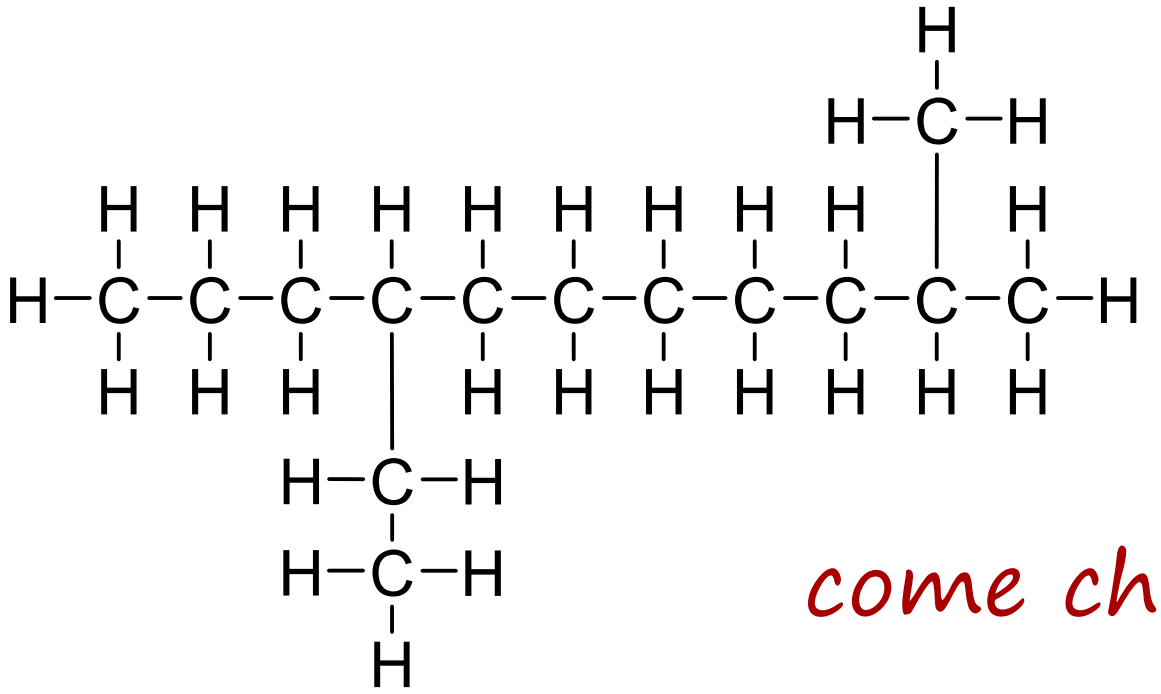
n-esano



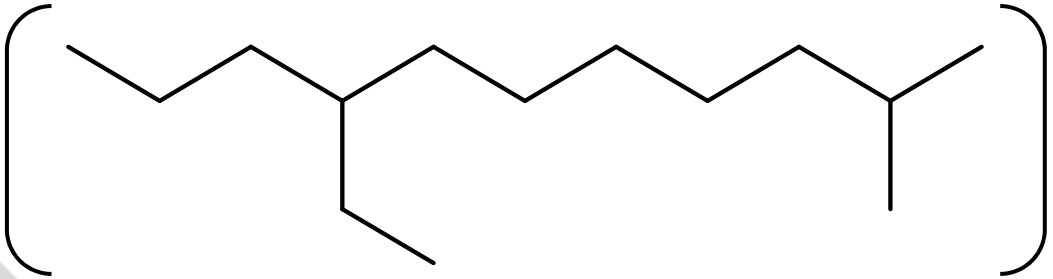




alcani

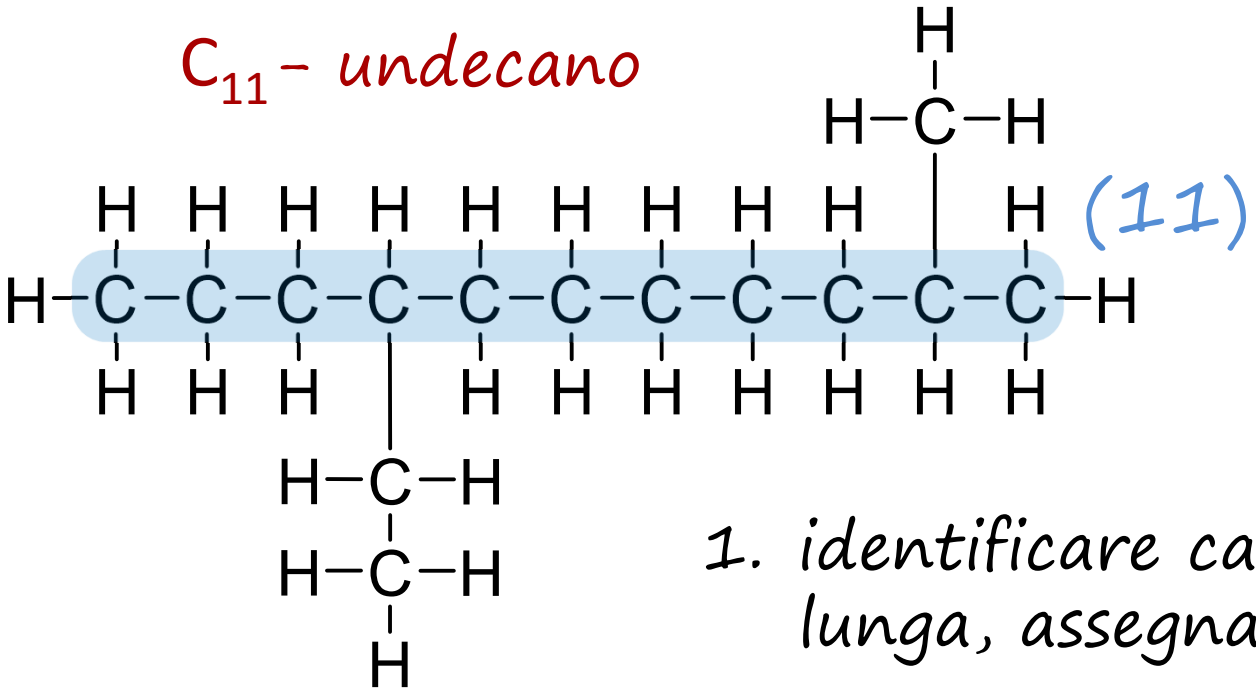


come chiamarlo?



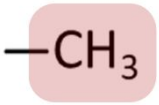
alcani

C_{11} - *undecano*

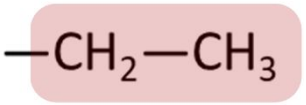


1. identificare catena più lunga, assegnare il nome

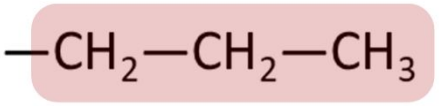
gruppi alchilici



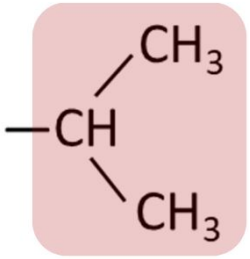
metile



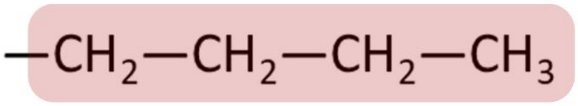
etile



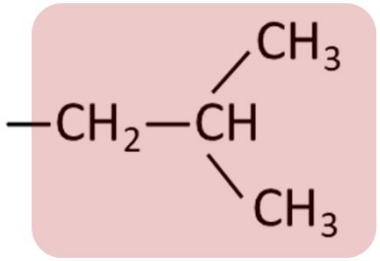
propile



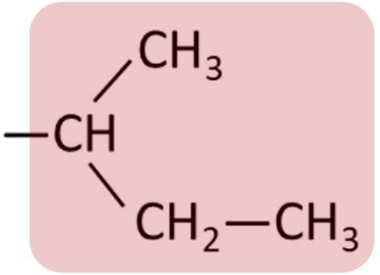
isopropile
(1-metil-etile)



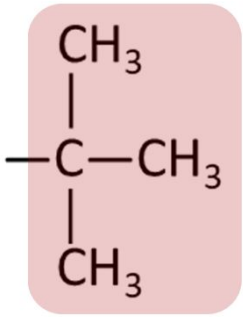
butile



isobutile
(2-metil-propile)



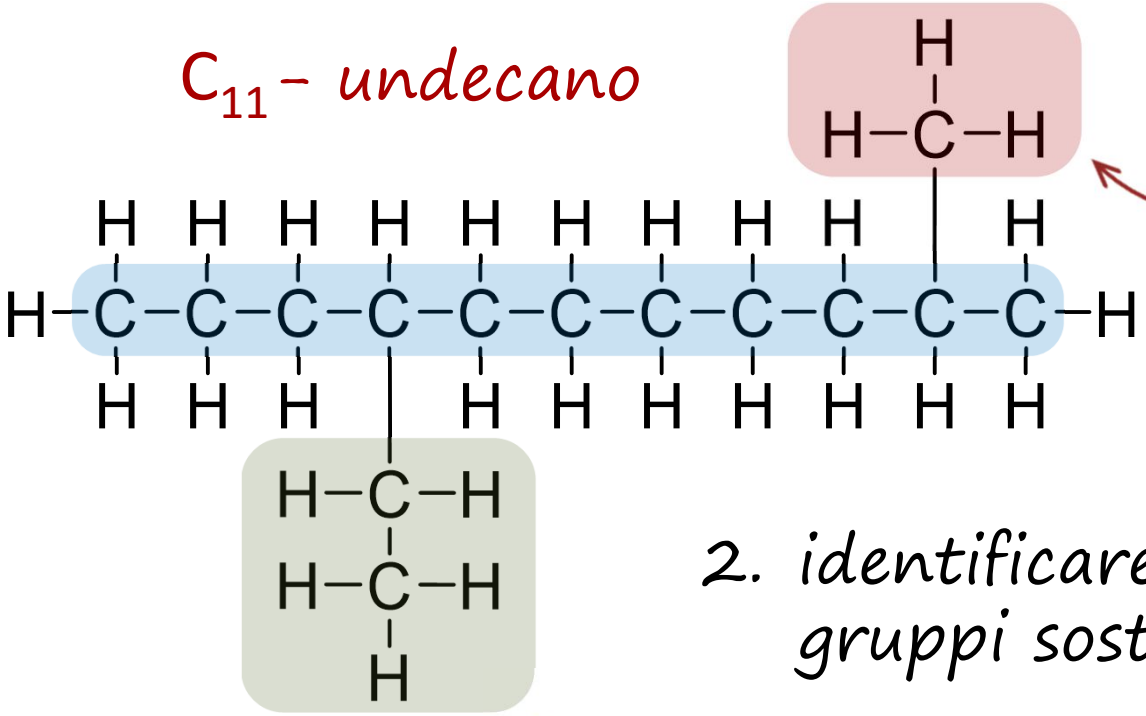
s-butile
(1-metil-propile)



t-butile
(1,1-dimetil-etile)

alcani

C_{11} - *undecano*

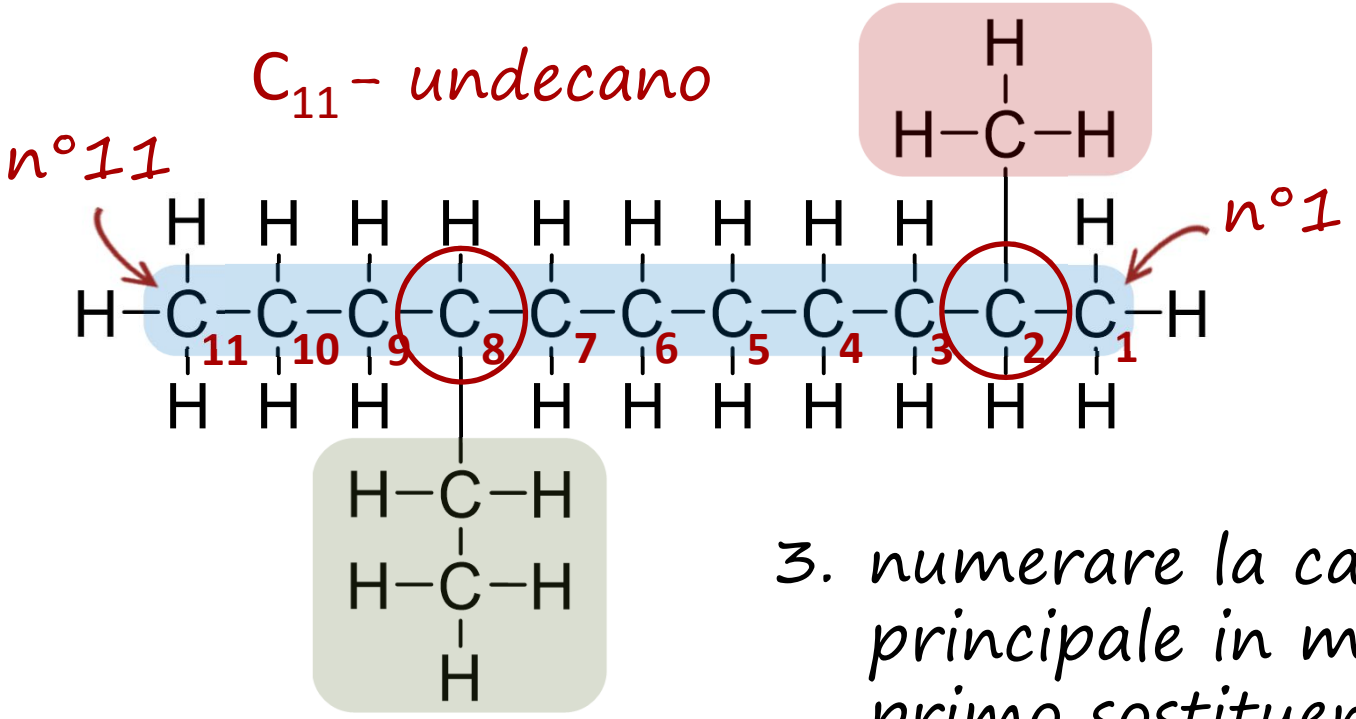


gruppo metile

gruppo etile

2. *identificare/denominare gruppi sostituenti*

alcani

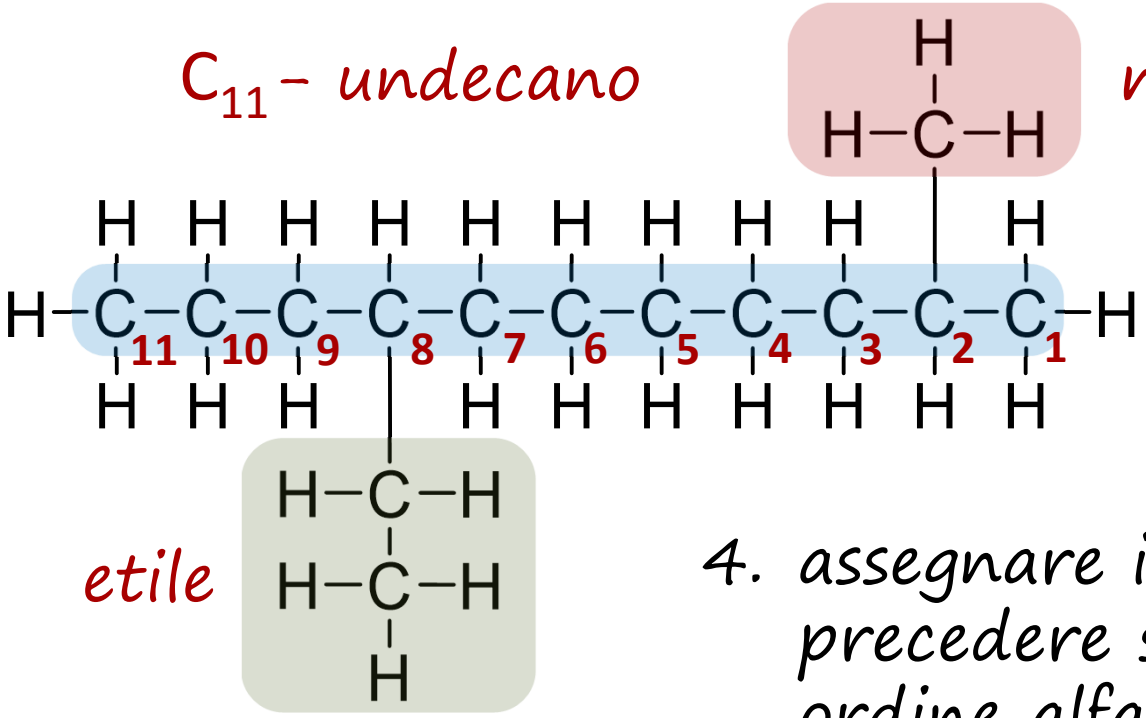


3. numerare la catena principale in modo che il primo sostituente abbia il numero più basso

alcani

C_{11} - undecano

metile



etile

4. assegnare il nome, facendo precedere sostituenti in ordine alfabetico

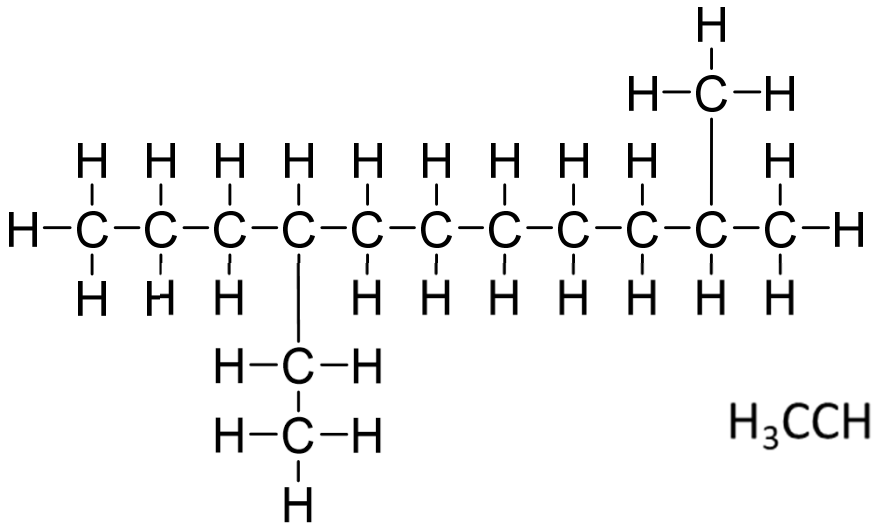
8 - etil - 2 - metil - undecano

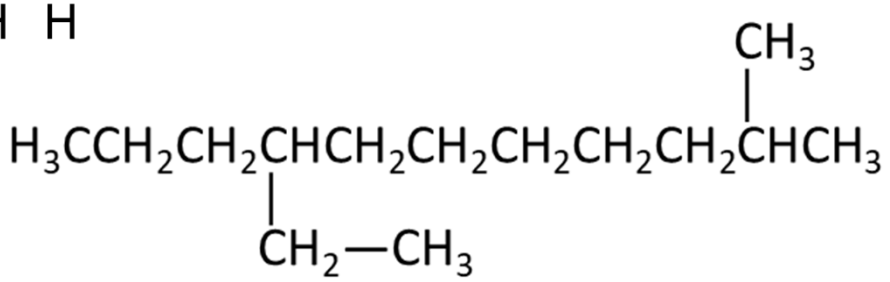
posizione sostituente

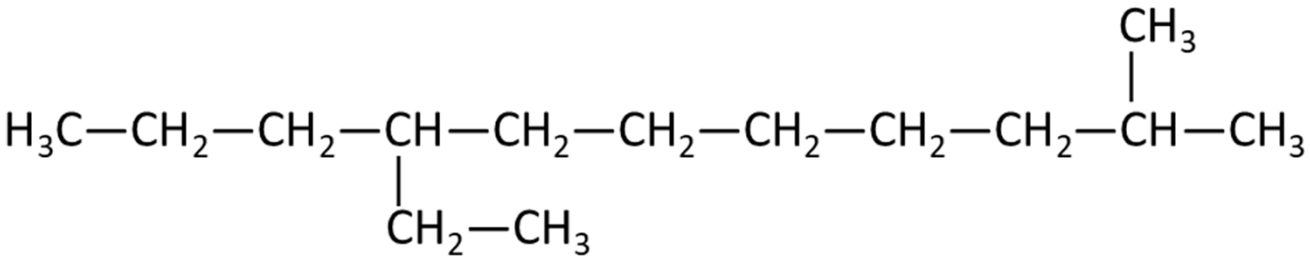
nome sostituente (senza ultima lettera)

nome catena principale

alcani

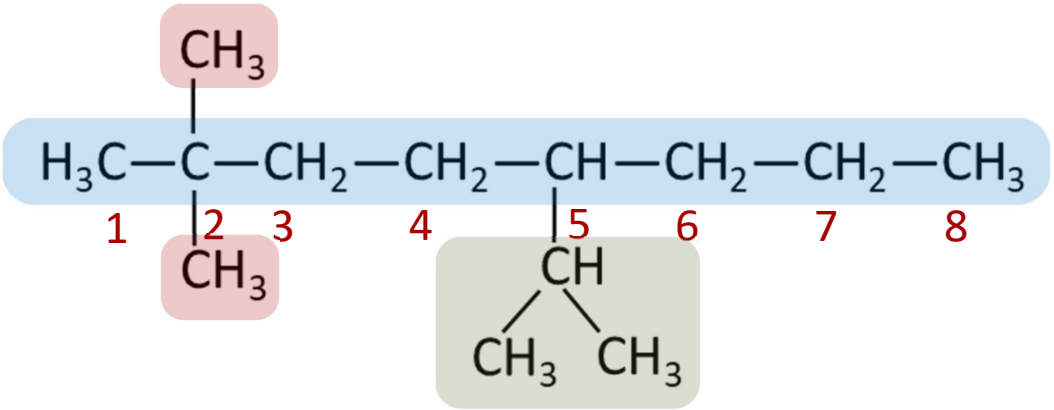






8 - etil - 2 - metil - undecano

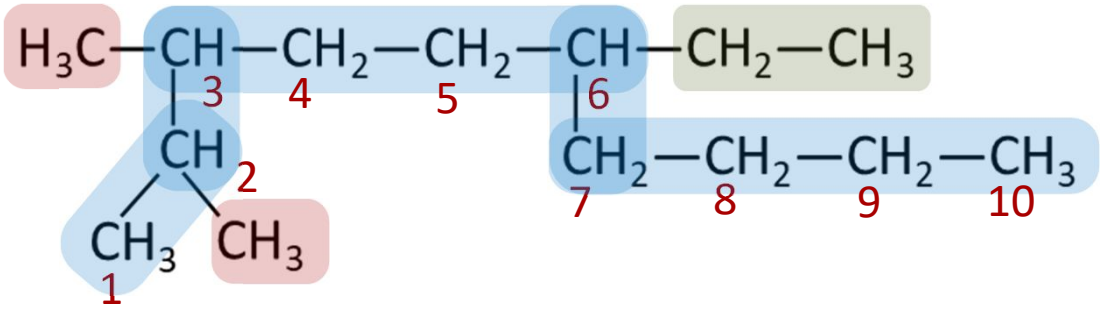
alcani



5-isopropil-2,2-*di*metil-ottano

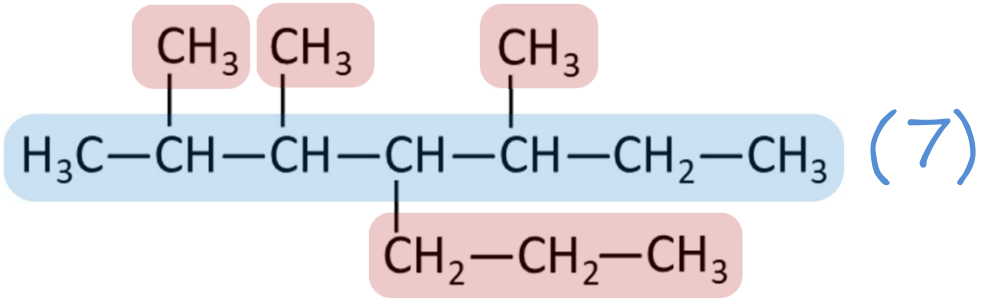
se più gruppi alchilici identici, usare ***prefissi*** *di-, tri-, etc. indicando le posizioni con numeri (il prefisso non conta ai fini dell'ordine alfabetico)*

alcani



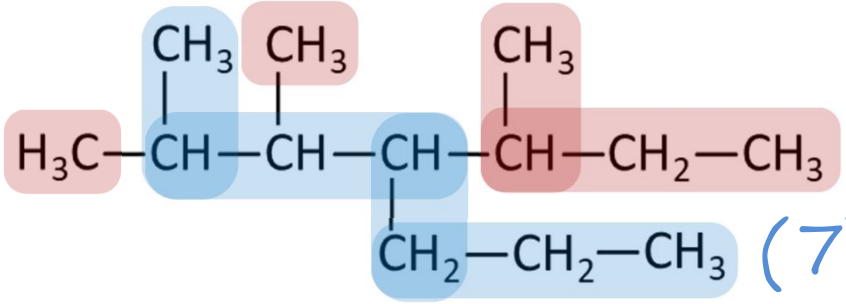
6-etil-2,3-*di*metil-decano

alcani



(7)

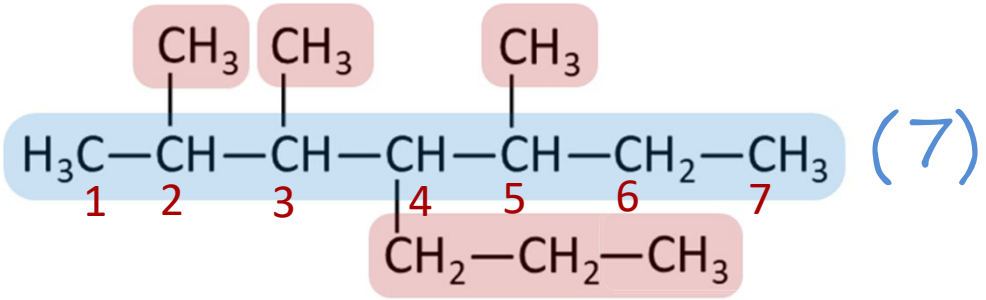
(4 sostituenti)



(7)

(3 sostituenti)

alcani



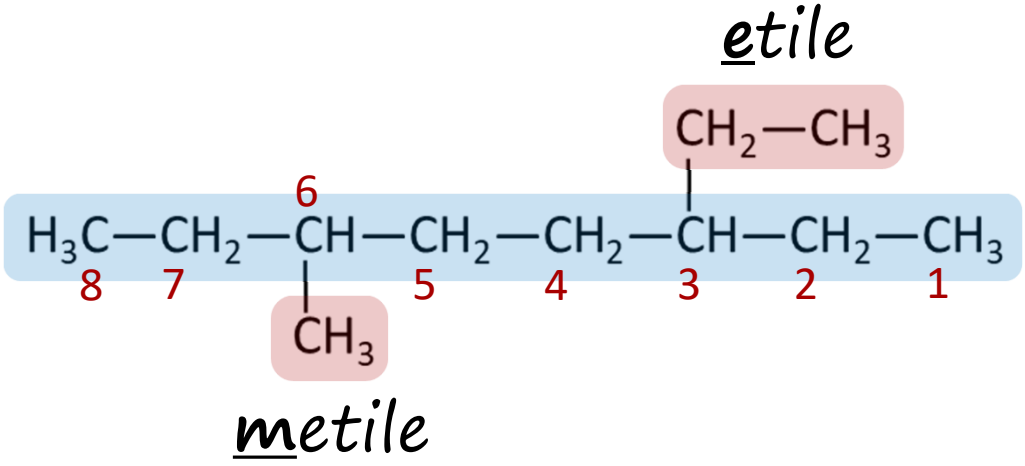
(7)

(4 sostituenti)

2,3,5-trimetil-4-propil-eptano

se più catene di uguale lunghezza,
scegliere quella con **più sostituenti**

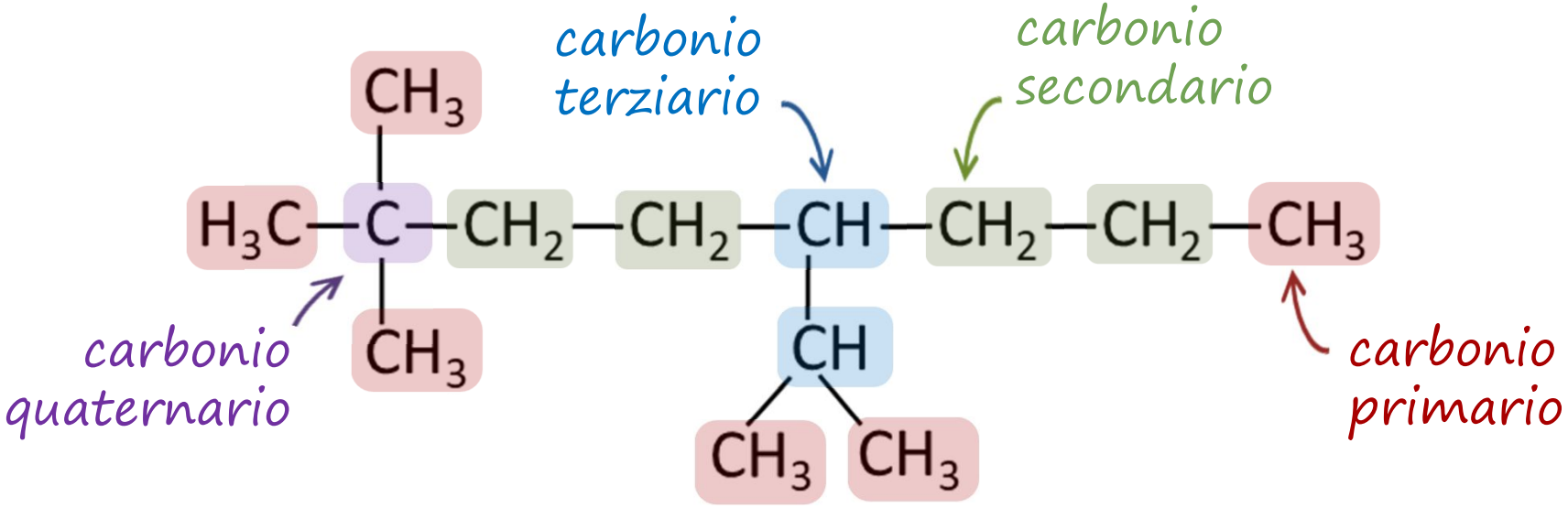
alcani



3-etil-6-metil-ottano

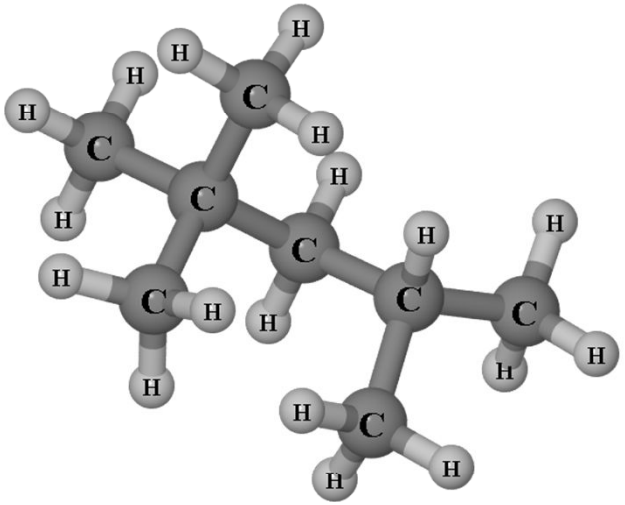
se più sostituenti in posizioni equidistanti
da fine catena, precedenza numerazione
per ordine alfabetico

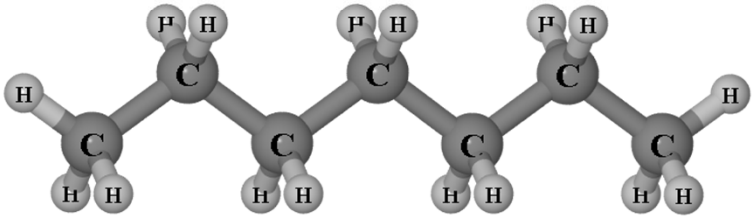
alcani

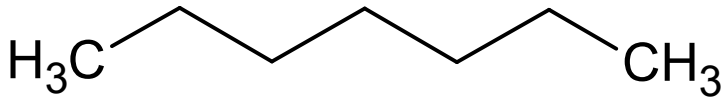


classificazione carbonio a seconda di quanti altri carboni lega

n° di ottani



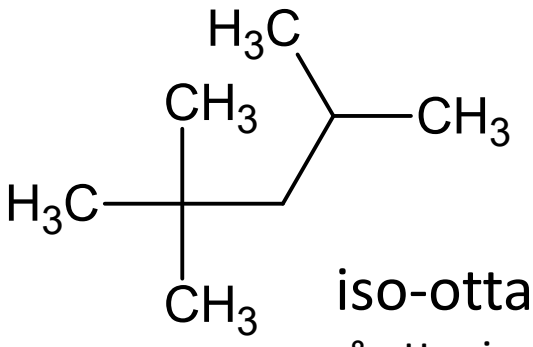




n-eptano

n° ottani = 0

(molto detonante)

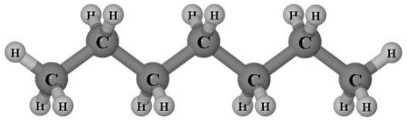


iso-ottano

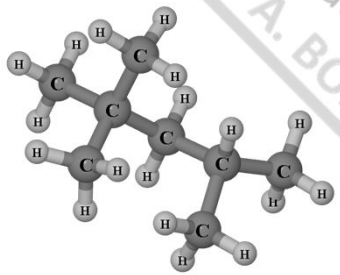
n° ottani = 100

(poco detonante)

n° di ottani

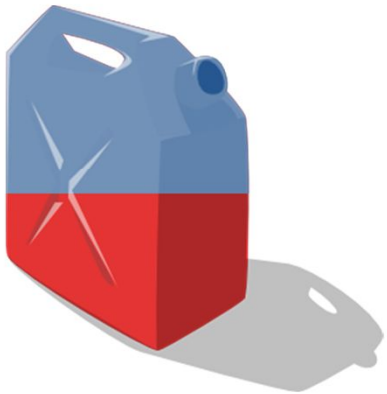


N° ottani = 0
(100% n-eptano)

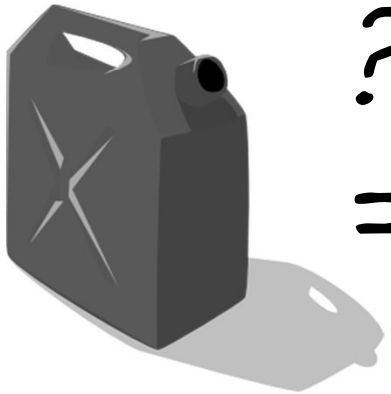


N° ottani = 100
(100% iso-ottano)

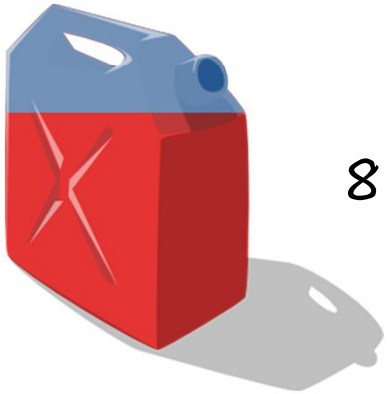
N° ottani = 50
(50% iso-ottano
50% n-eptano)



campione di benzina (potere detonante non noto)

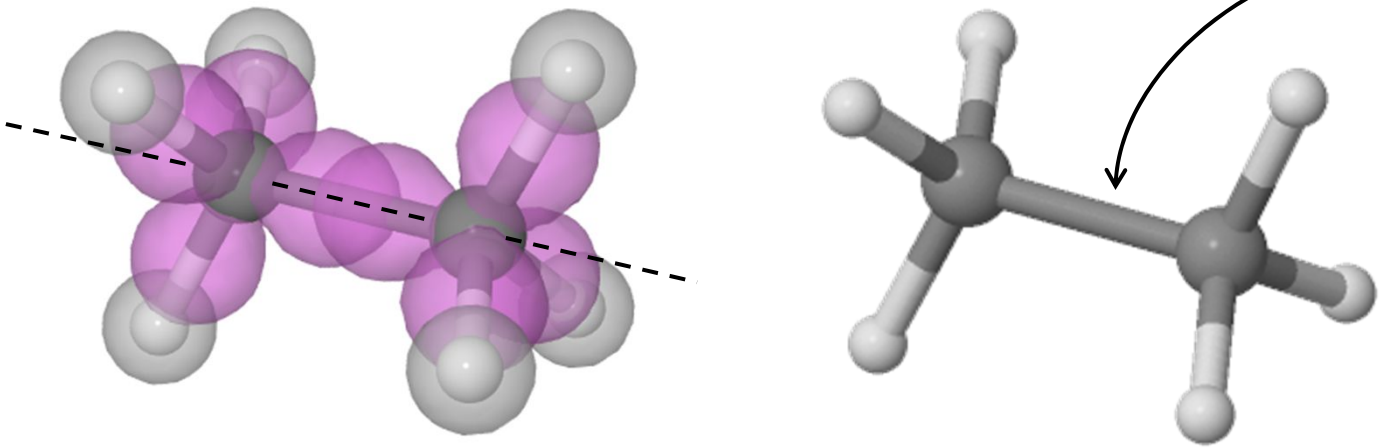


?
=



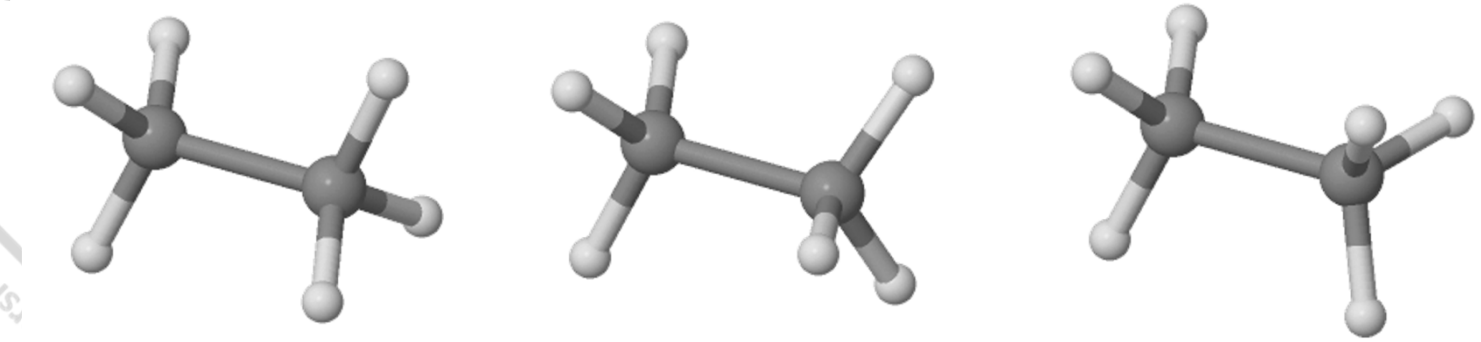
pari a 85% ottani

conformazione molecolare



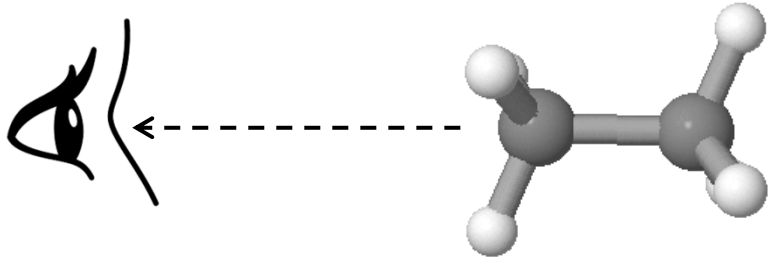
rotazione possibile attorno al legame

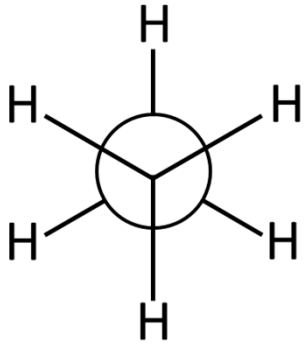
conformeri (rotameri)



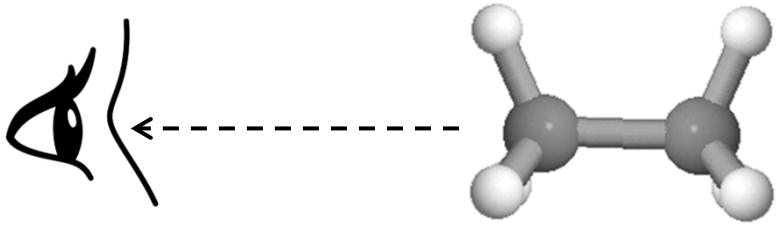
conformazione molecolare

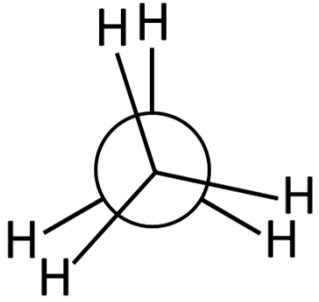
proiezione
di Newman





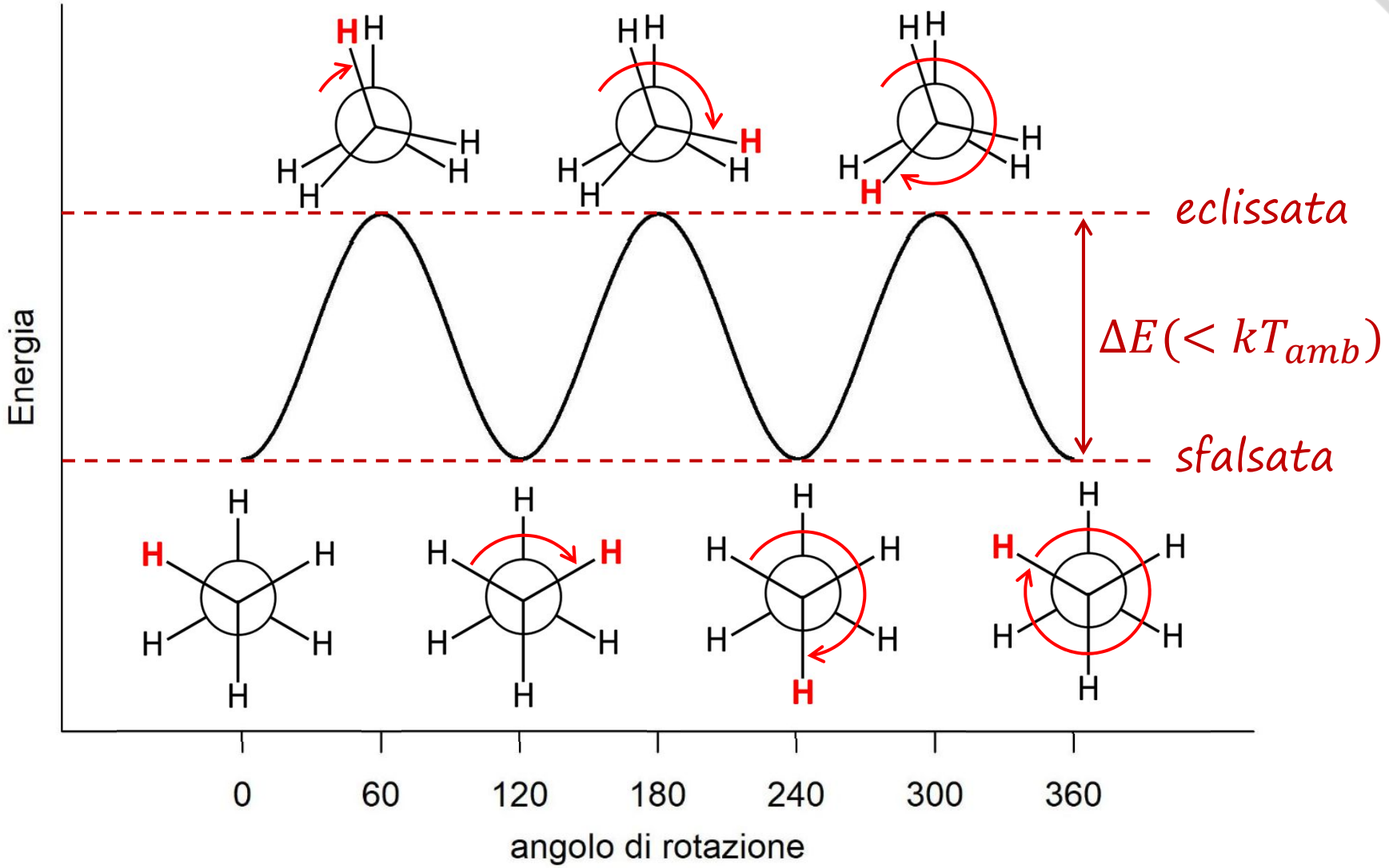
conformazione
sfalsata



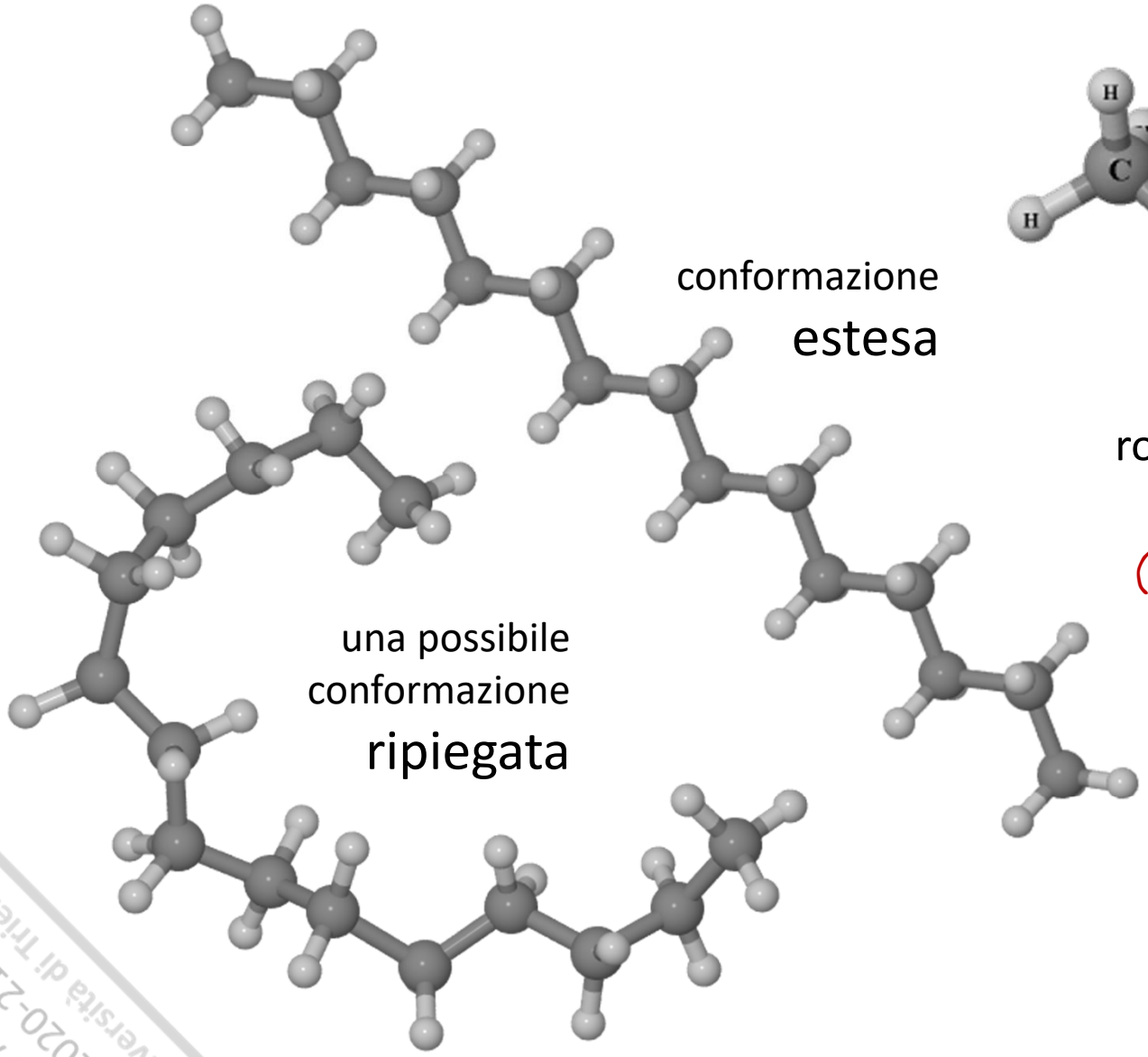


conformazione
eclissata

conformazione molecolare

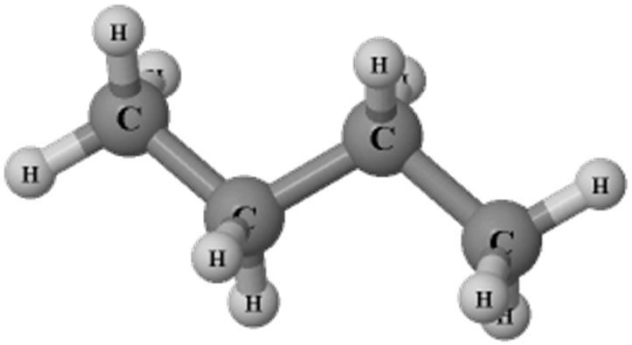


conformazione molecolare



conformazione
estesa

una possibile
conformazione
ripiegata

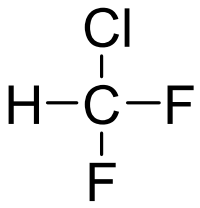


rotazione possibile
attorno C—C
(a T ambiente)

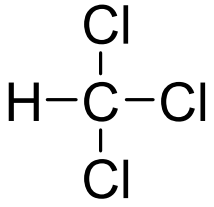
alogenuri alchilici

poco reattivi (paraffine, da parum affinum)

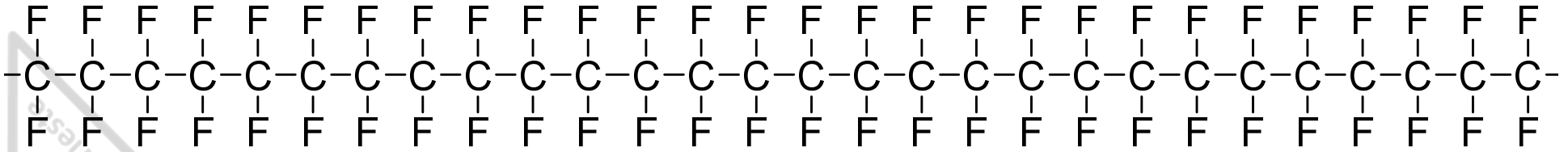
ma reagiscono in alogeni → **alogenuri alchilici**



freon
(cloro-difluoro-metano)



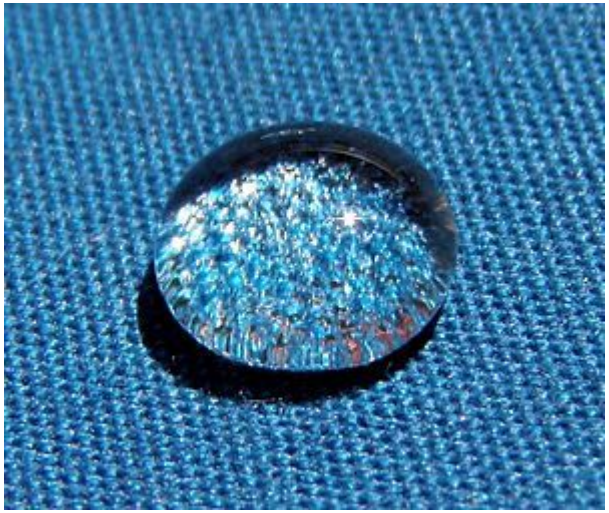
cloroformio
(tricloro-metano)

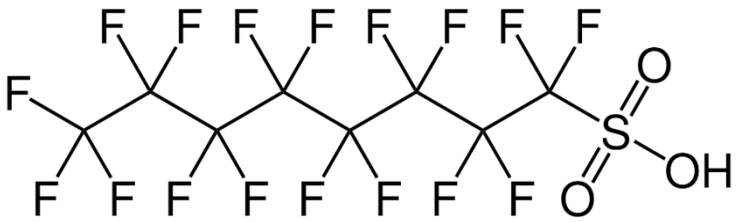


teflon
(poli-tetrafluoro-etilene)

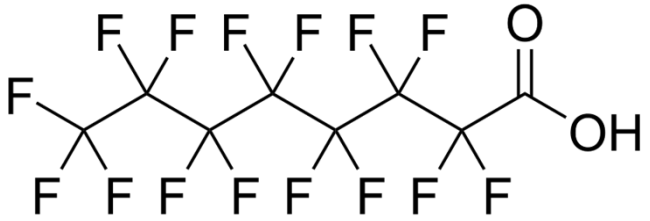
alogenuri alchilici

PFAS (perfluoroalkyl substances)





(PFOS)

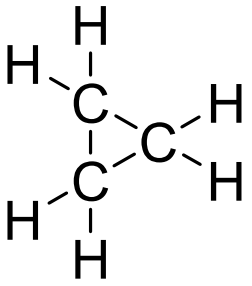


(PFOA)

- molto usati per rendere tessuti idro-repellenti
- inquinanti persistenti
- probabilmente effetti sulla salute

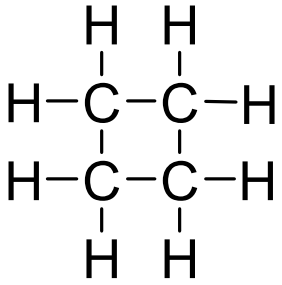
cicloalcani

C_nH_{2n} *alcani ciclici*



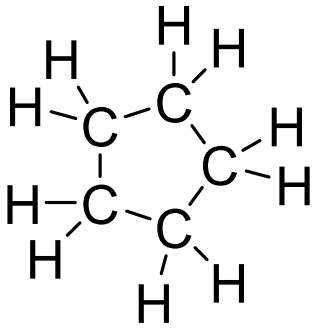
C_3H_6

ciclopropano



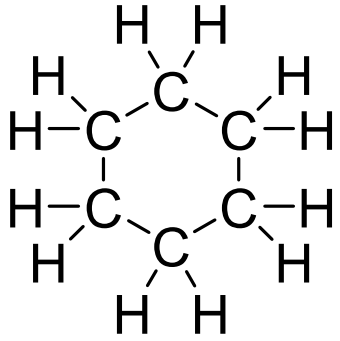
C_4H_8

ciclobutano



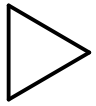
C_5H_{10}

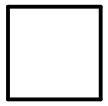
ciclopentano

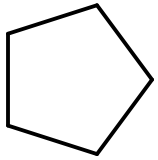


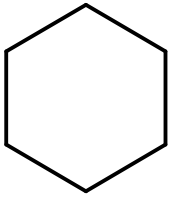
C_6H_{12}

cicloesano



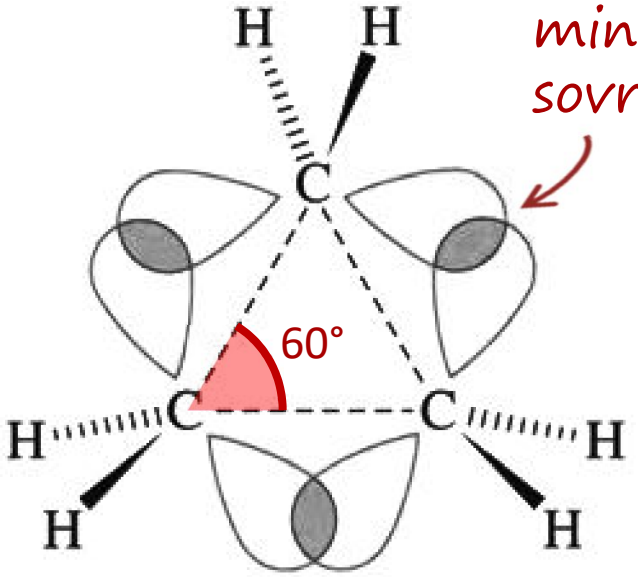






cicloalcani

C_nH_{2n} *alcani ciclici*



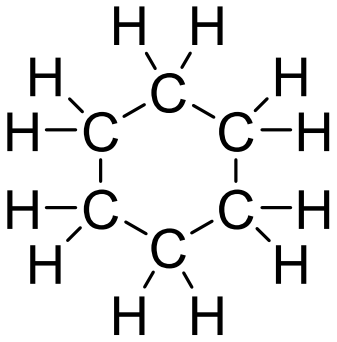
minor sovrapposizione

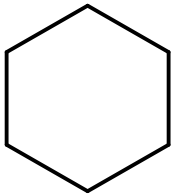
forte tensione angolare
=
alta reattività

angoli di legame < 109.5°
(C tetraedrico)

cicloalcani

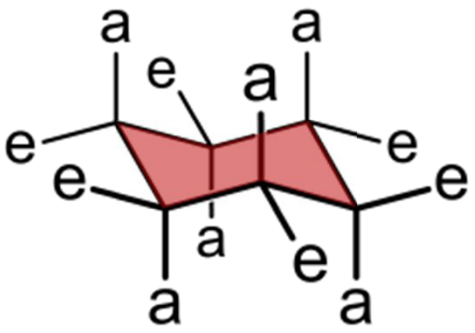
conformazioni per il cicloesano



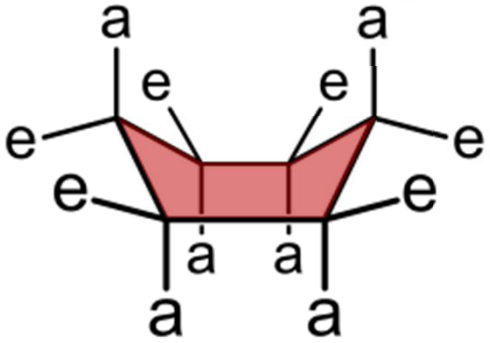


molecola non planare

posizione assiale



sedia

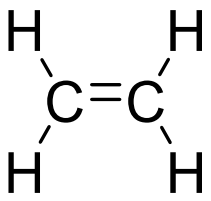


barca

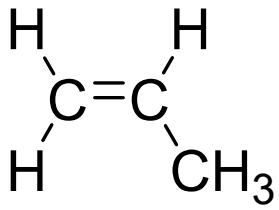
posizione equatoriale

alcheni

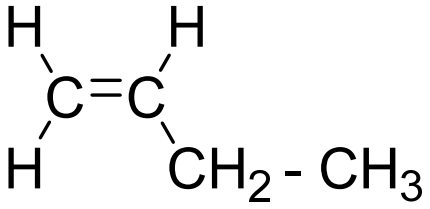
C_nH_{2n} *presenza legami* ***doppi***



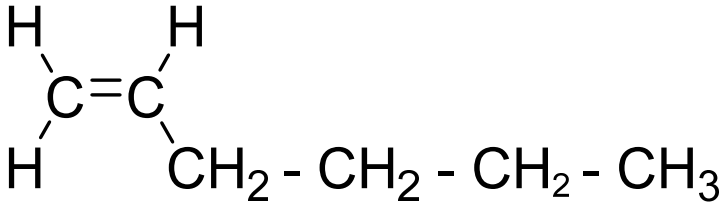
C_2H_4



C_3H_6



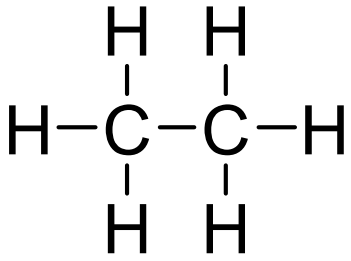
C_4H_8



C_6H_{12}

alcheni

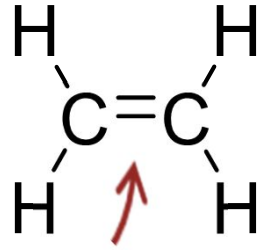
alcani



idrocarburi *saturi*

(i carboni sono saturi di H, non è più possibile aggiungere altri H)

alcheni



insaturazione

idrocarburi *insaturi*

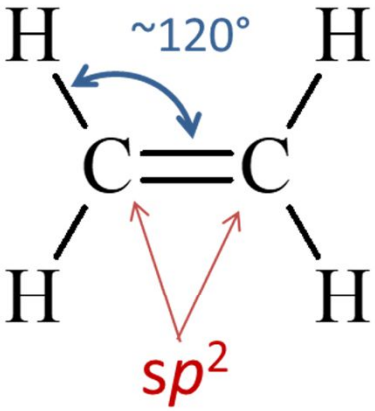
(alcuni carboni sono insaturi di H, è possibile aggiungerne altri)

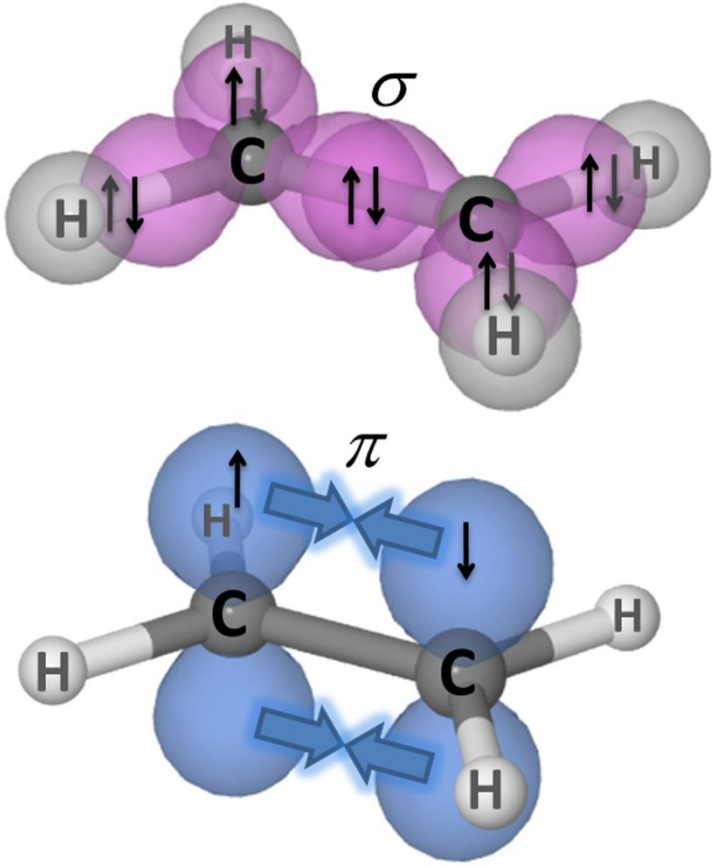
alcheni

C_nH_{2n}

anche carbonio sp^2
(trigonale planare)

C_2H_4





alcheni

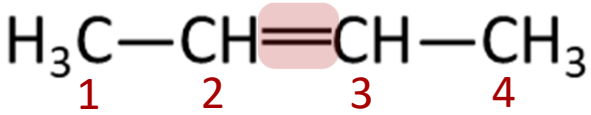
C_nH_{2n}

nomenclatura

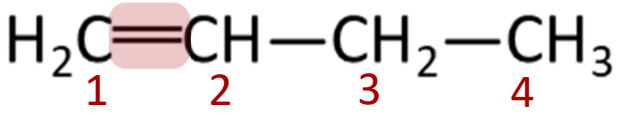
(n° carboni) -**ene**

nome	n° atomi carbonio	formula	formula condensata
*et*ene	2	C_2H_4	$CH_2=CH_2$
*prop*ene	3	C_3H_6	$CH_2=CHCH_3$
*but*ene	4	C_4H_8	$CH_2=CHCH_2CH_3$
*pent*ene	5	C_5H_{10}	$CH_2=CHCH_2CH_2CH_3$
*es*ene	6	C_6H_{12}	$CH_2=CH(CH_2)_3CH_3$
*ept*ene	7	C_7H_{14}	$CH_2=CH(CH_2)_4CH_3$

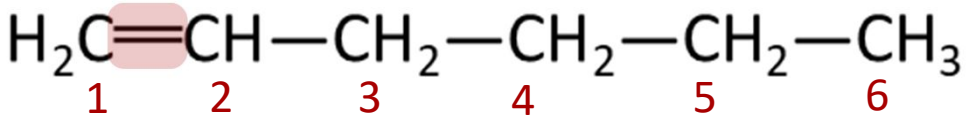
alcheni



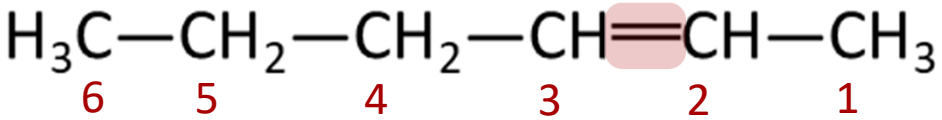
2-butene



1-butene

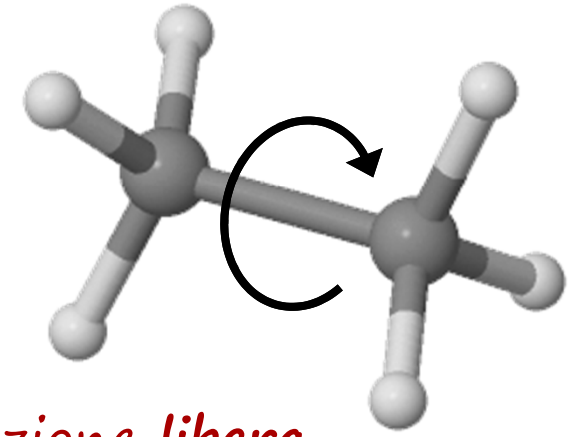


1-esene

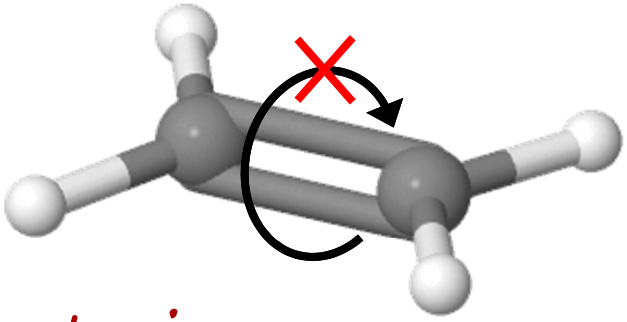


2-esene

alcheni



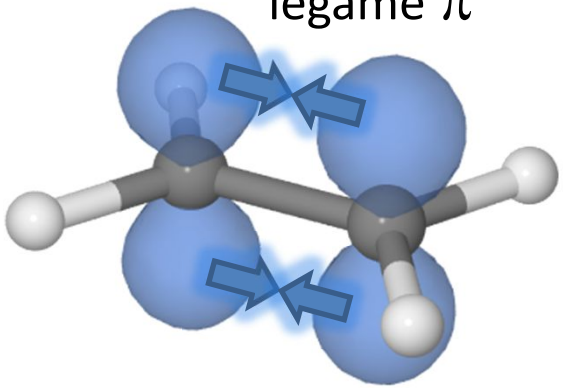
rotazione **libera** attorno al legame

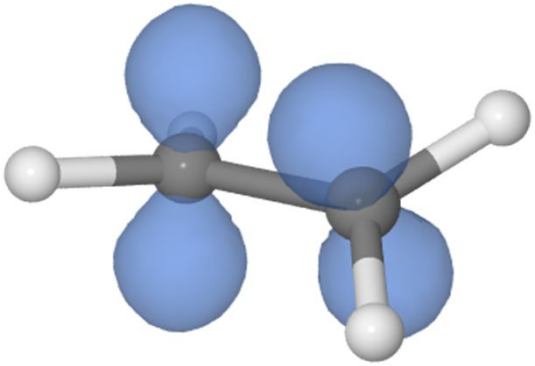


rotazione **molto sfavorita**

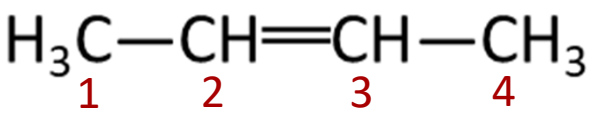
diminuisce la **sovrapposizione** tra orbitali p

legame π

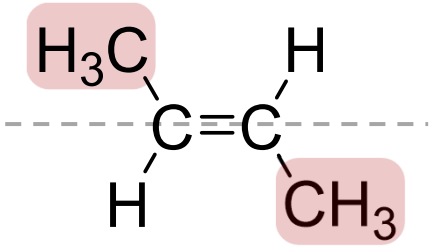




alcheni

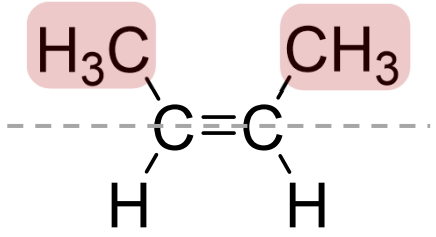


2-butene



trans-2-butene

da parti opposte rispetto all'asse del doppio legame



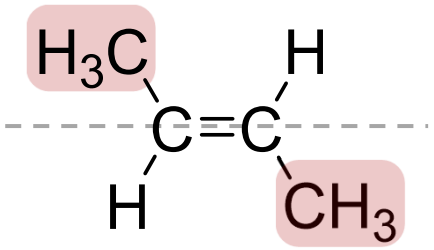
cis-2-butene

dalla stessa parte rispetto all'asse del doppio legame

alcheni

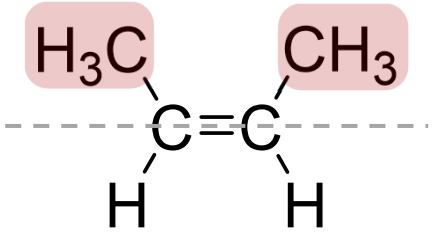
stessa formula, diversa forma

ISOMERI



trans-2-butene

da parti opposte rispetto all'asse del doppio legame



cis-2-butene

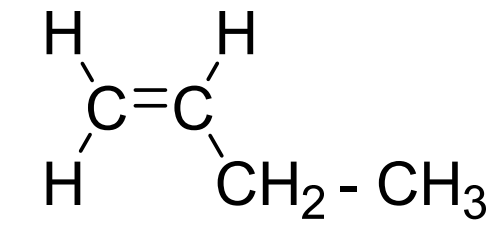
dalla stessa parte rispetto all'asse del doppio legame

alcheni

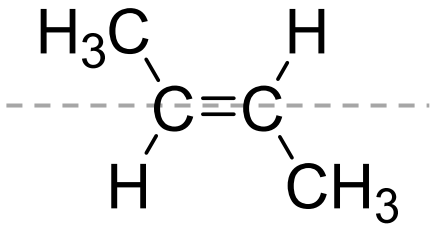
stessa formula, struttura diversa

isomeri *strutturali*

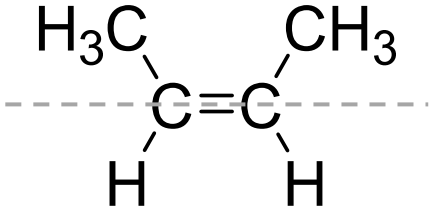
2 tipi diversi di isomeria!!!



1-butene



trans-2-butene



cis-2-butene

isomeri *geometrici*

STEREOISOMERIA

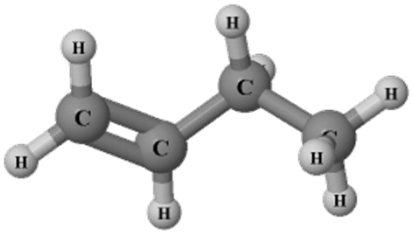
stessa formula, stessa struttura
DIVERSA GEOMETRIA

alcheni

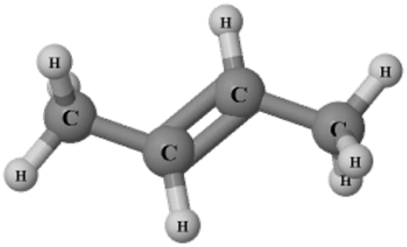
stessa formula, struttura diversa

isomeri *strutturali*

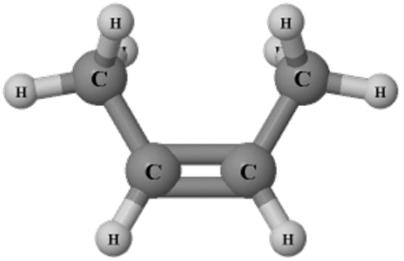
2 tipi diversi di isomeria!!!



1-butene



trans-2-butene



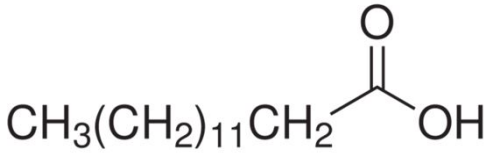
cis-2-butene

isomeri *geometrici*

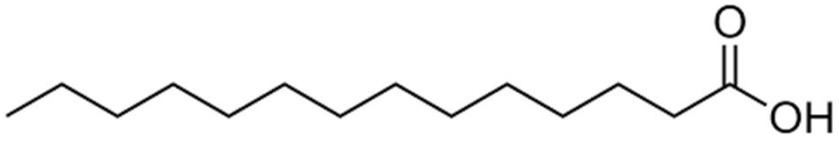
STEREOISOMERIA

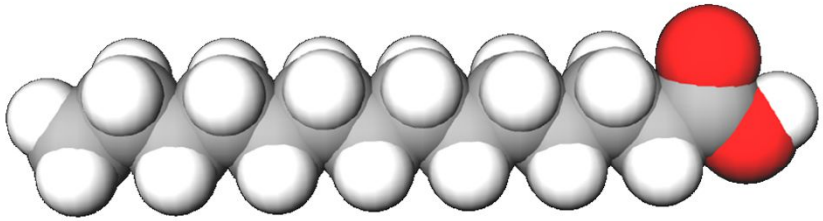
stessa formula, stessa struttura
DIVERSA GEOMETRIA

grassi saturi ed insaturi

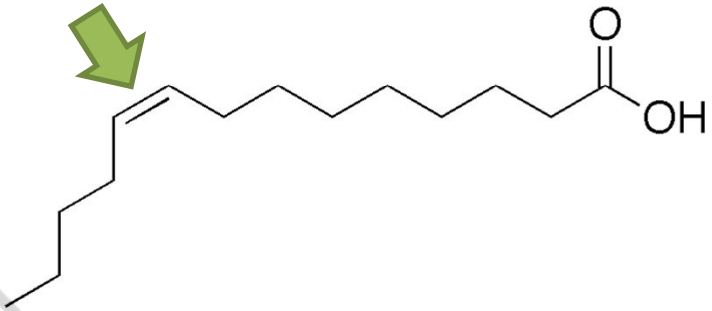


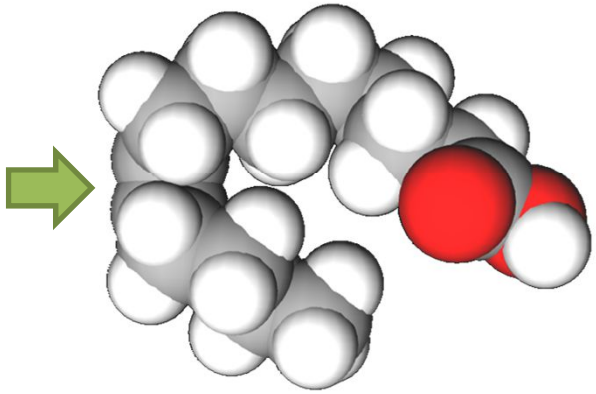
(acido miristico)



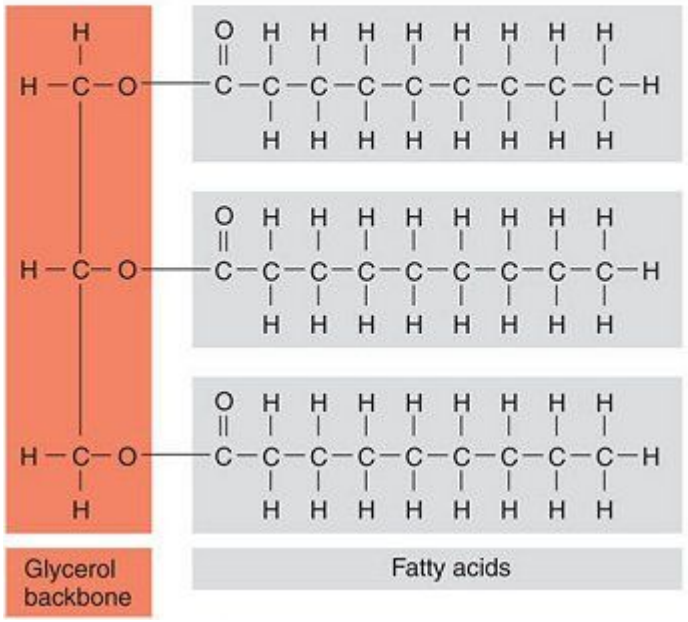


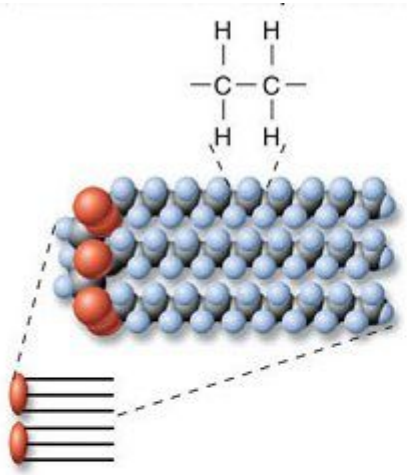
(acido miristoleico)

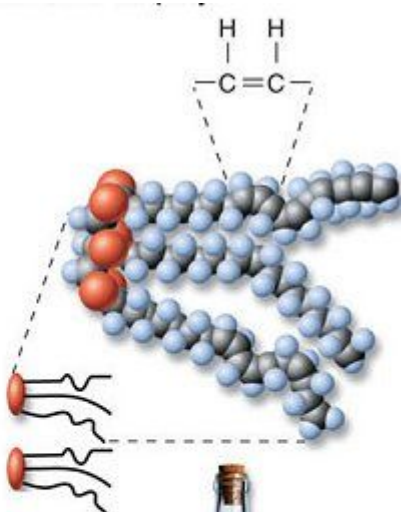




grassi saturi ed insaturi





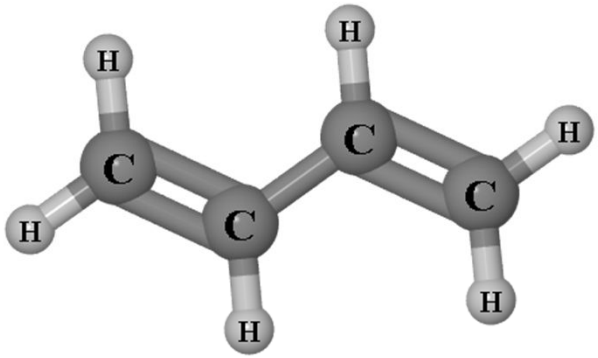


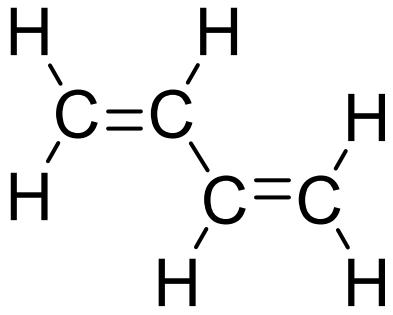
alcheni

è possibile la presenza di più doppi legami (polieni)

$H_2C{=}CH{-}CH{=}CH_2$

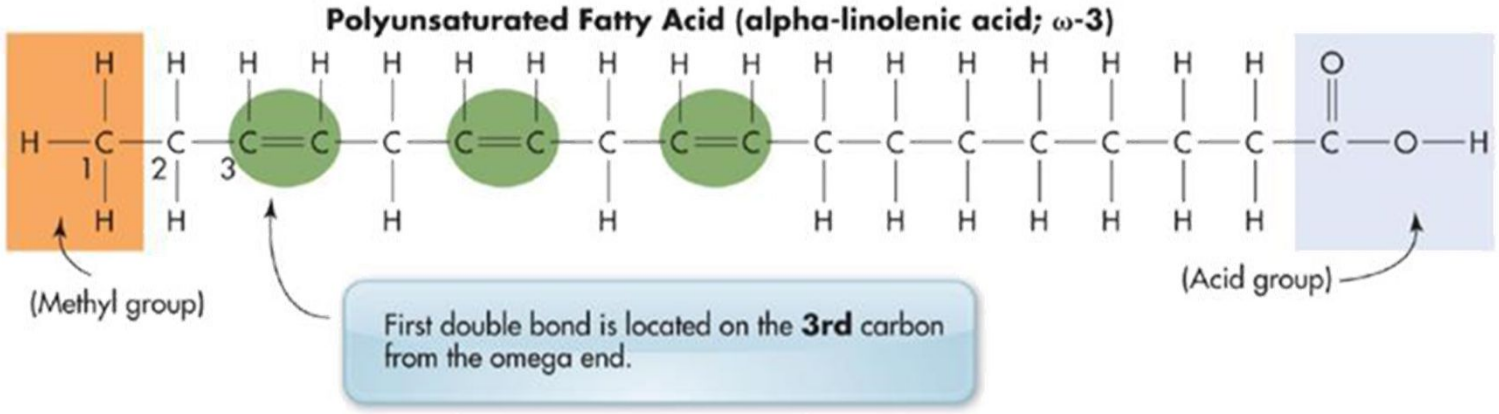
buta*diene*

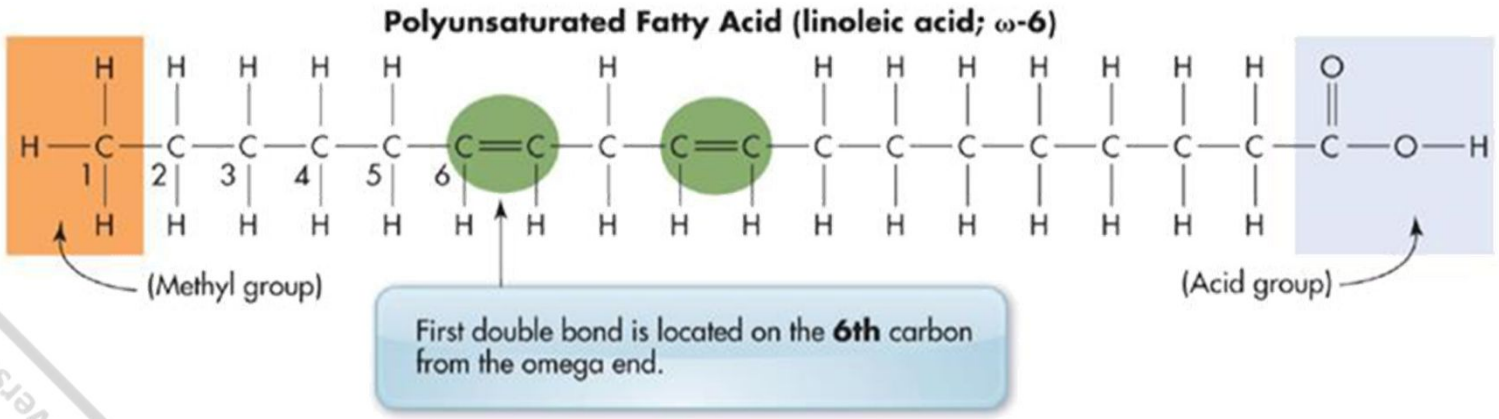




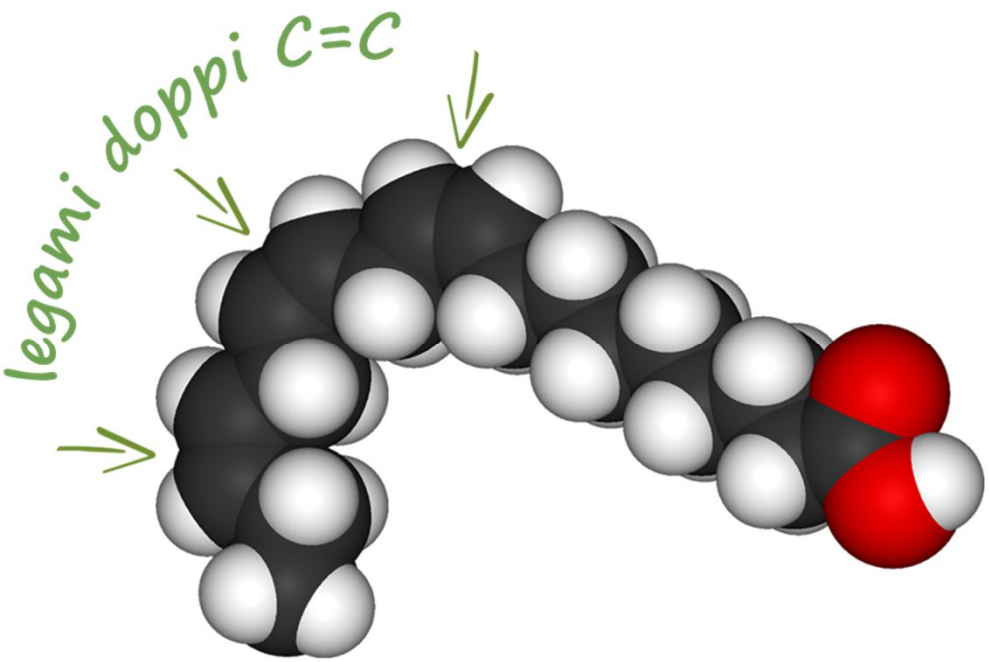
grassi *poli*-insaturi

omega-3 e omega-6

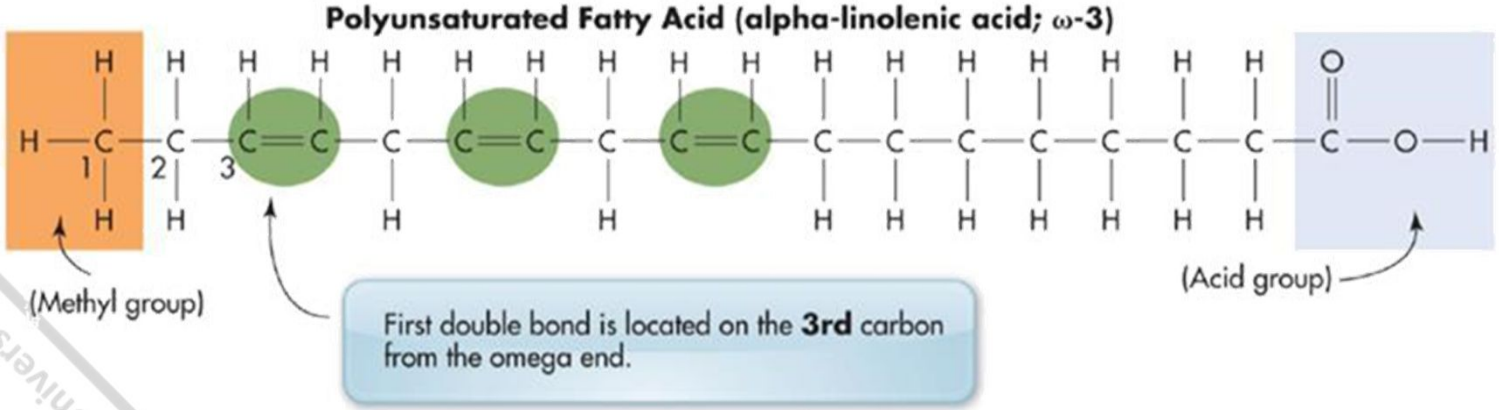




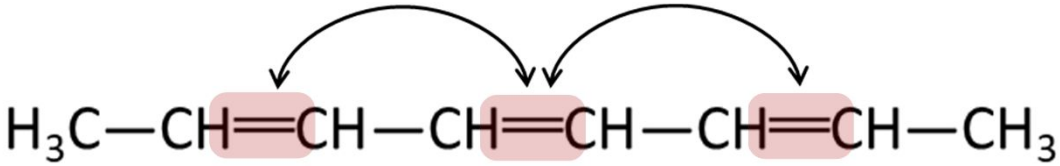
grassi *poli*-insaturi



geometria
non lineare



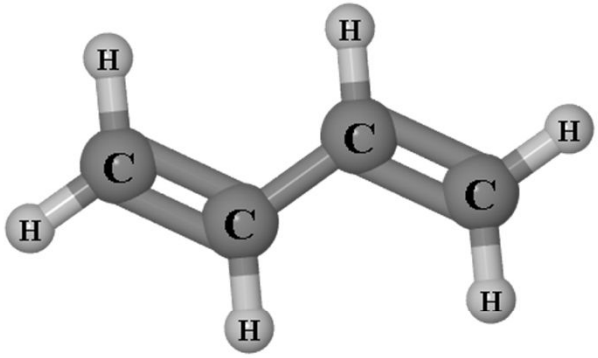
polieni coniugati



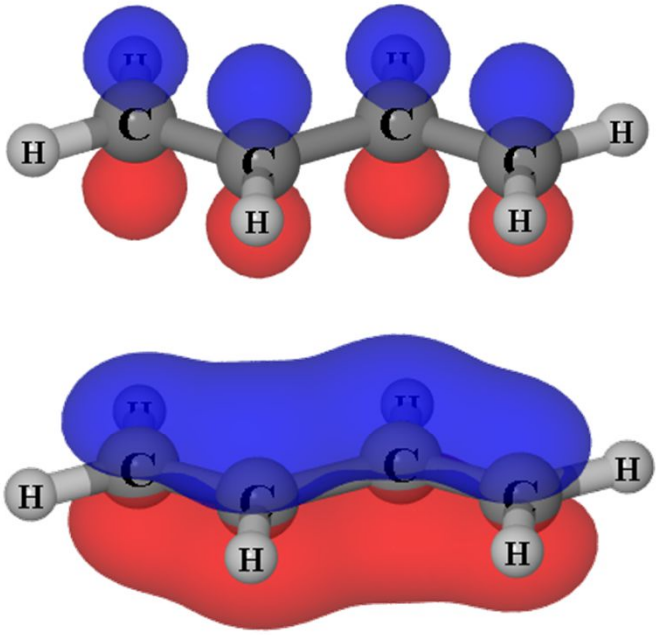
alternati

se i doppi legami sono "*coniugati*"

→ sistema π delicalizzato



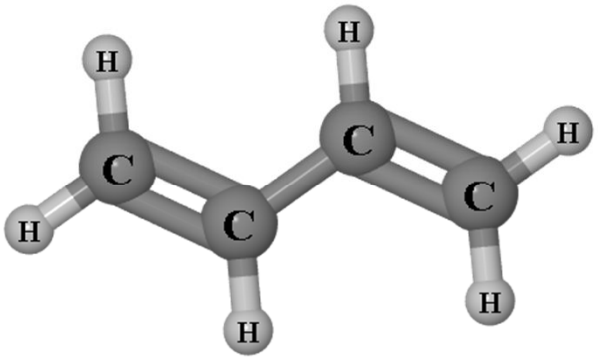
buta*diene*



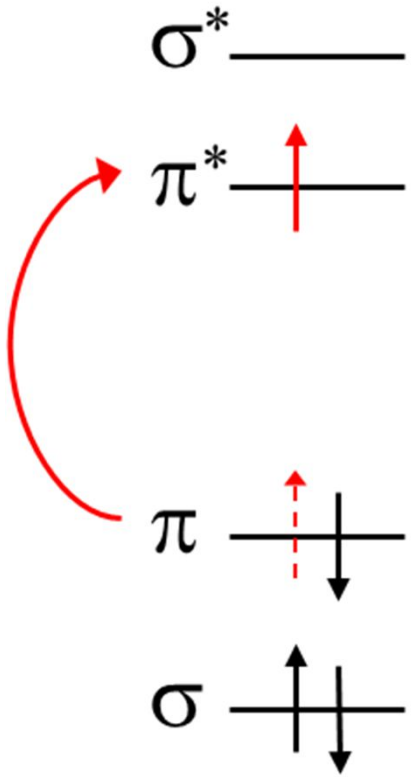
(esempio orbitale molecolare legante)

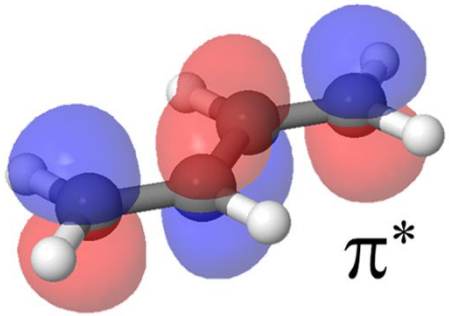
polieni coniugati

*sono comuni le transizioni π–π**

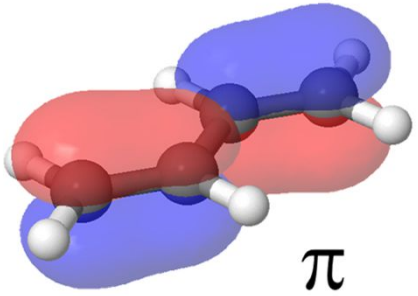


buta*diene*





primo OM libero



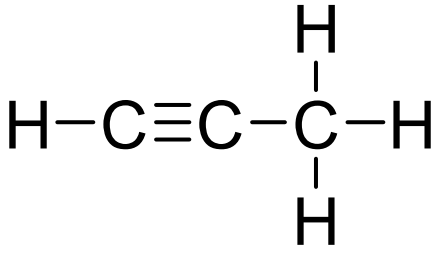
ultimo OM occupato

$$\pi \longrightarrow \pi^*$$

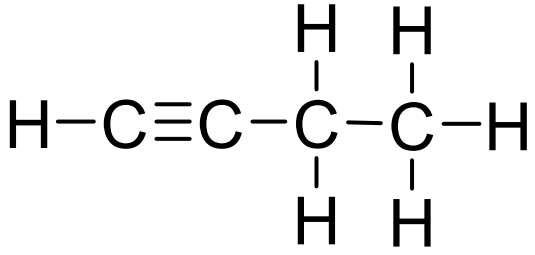
alchini

C_nH_{2n-2} *presenza legami* ***tripli***

C_2H_2



C_3H_4



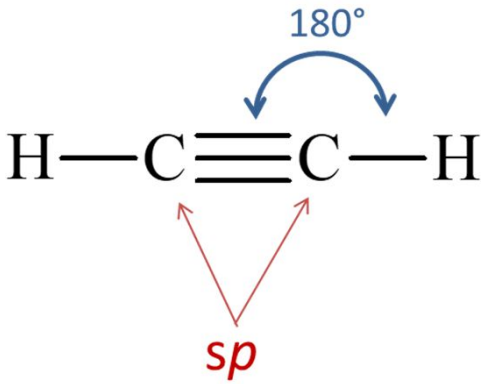
C_4H_6

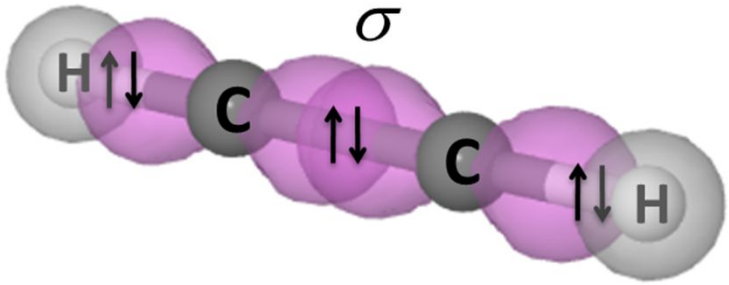
alchini

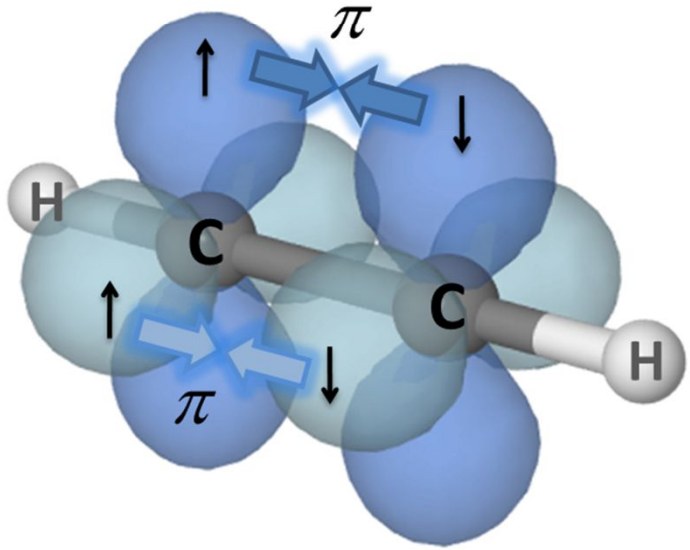
C_nH_{2n-2}

anche carbonio sp (lineare)

C_2H_2







alchini

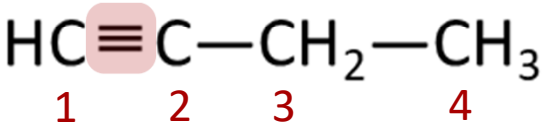
C_nH_{2n-2}

nomenclatura

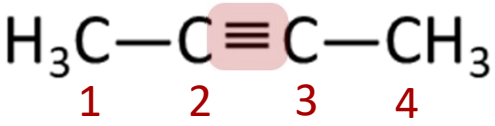
(n° carboni) **-ino**

nome	n° atomi carbonio	formula	formula condensata
*et*ino	2	C_2H_2	$CH \equiv CH$
*prop*ino	3	C_3H_4	$CH \equiv CCH_3$
*but*ino	4	C_4H_6	$CH \equiv CCH_2CH_3$
*pent*ino	5	C_5H_8	$CH \equiv CCH_2CH_2CH_3$
*es*ino	6	C_6H_{10}	$CH \equiv C(CH_2)_3CH_3$
*ept*ino	7	C_7H_{12}	$CH \equiv C(CH_2)_4CH_3$

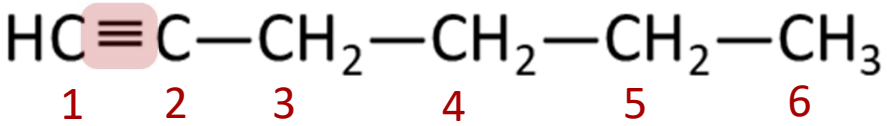
alchini



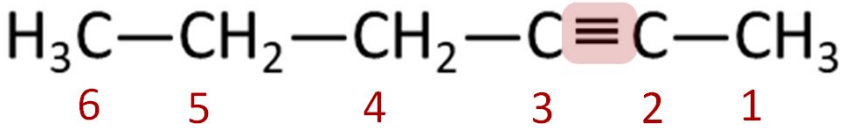
1-butino



2-butino

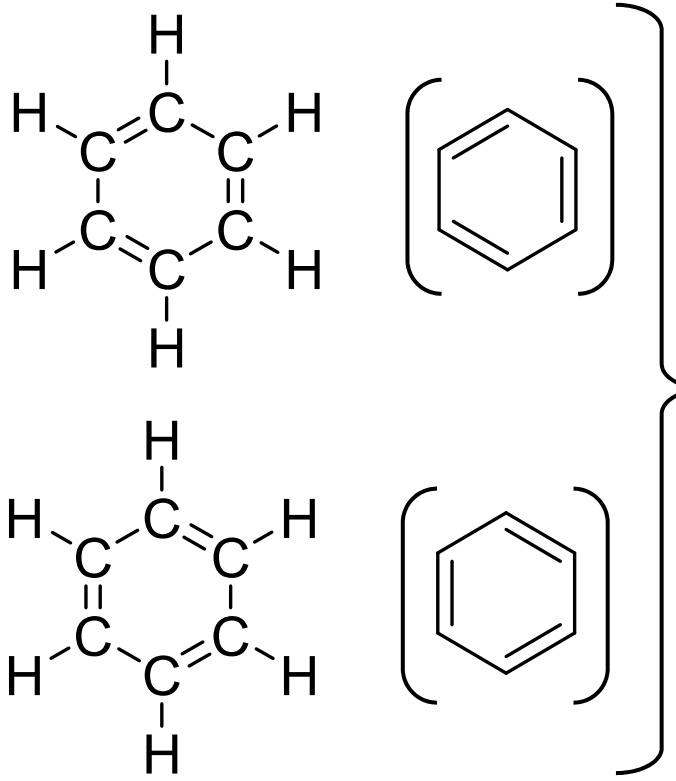


1-esino

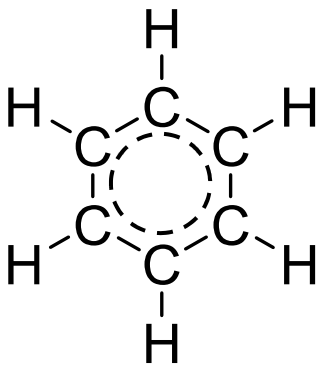


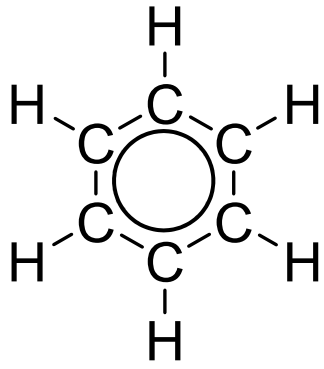
2-esino

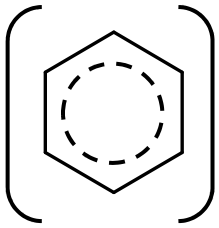
idrocarburi aromatici

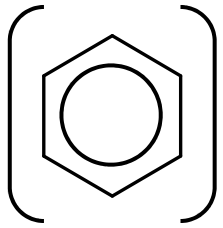


benzene



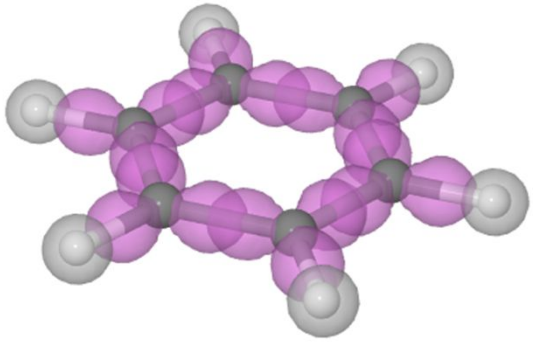


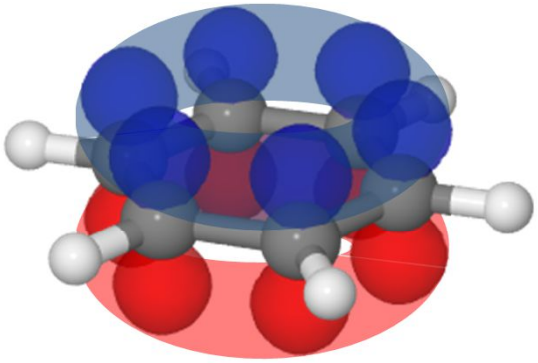




idrocarburi aromatici

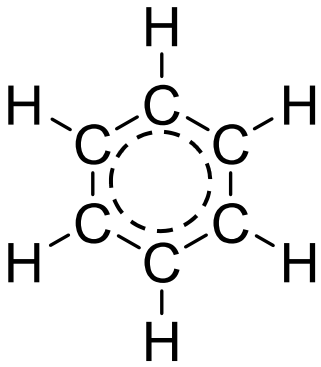
carbonio sp²

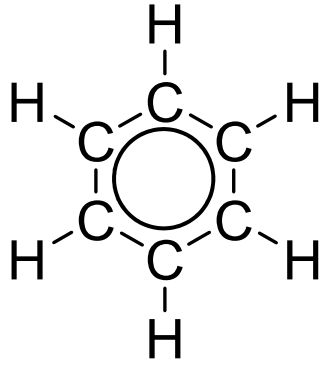


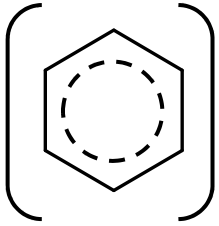


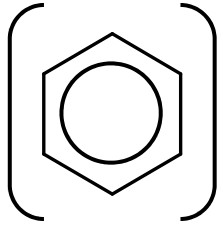
aromaticità

benzene



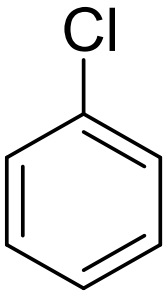




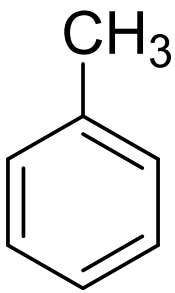


idrocarburi aromatici

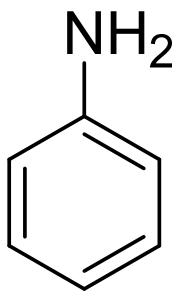
derivati mono-sostituiti



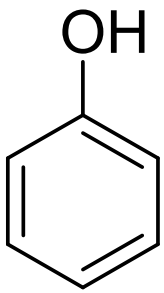
clorobenzene



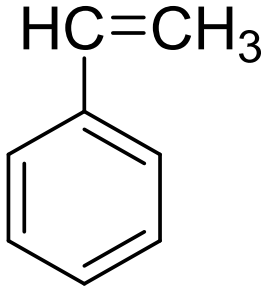
toluene



anilina



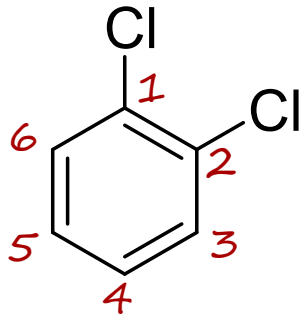
fenolo



stirene

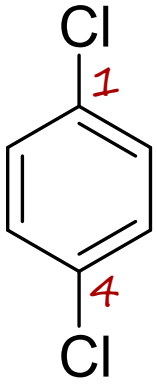
idrocarburi aromatici

derivati di-sostituiti



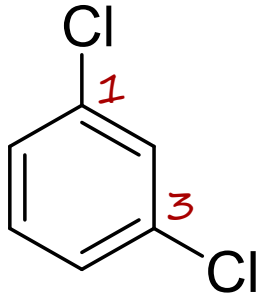
1,2-diclorobenzene
(orto-dibromobenzene)
(o-dibromobenzene)

orto-



1,4-diclorobenzene
(para-dibromobenzene)
(p-dibromobenzene)

para-

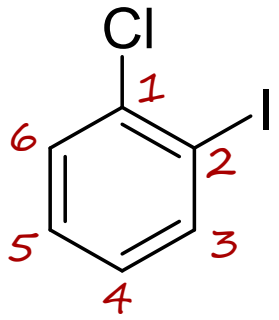


1,3-diclorobenzene
(meta-dibromobenzene)
(m-dibromobenzene)

meta-

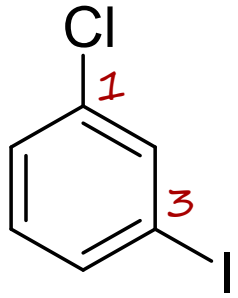
idrocarburi aromatici

derivati di-sostituiti



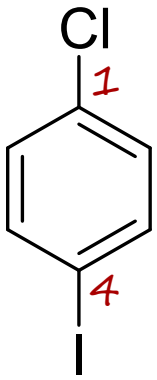
1-cloro-2-iodo-benzene
(orto-cloroiodobenzene)

orto-



1-cloro-3-iodo-benzene
(meta-cloroiodobenzene)

meta-

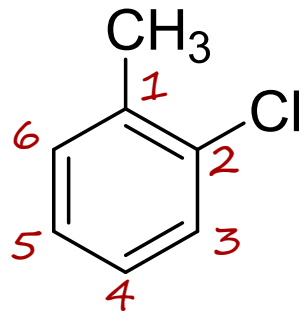


1-cloro-4-iodo-benzene
(para-cloroiodobenzene)

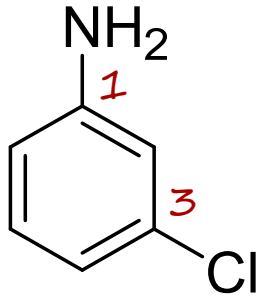
para-

idrocarburi aromatici

derivati di-sostituiti



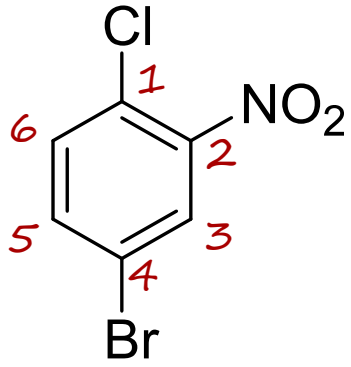
orto-clorotoluene



meta-cloroanilina

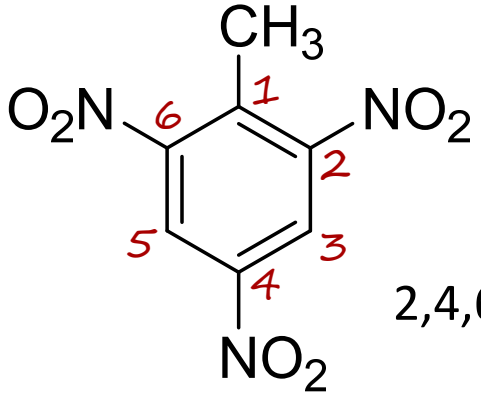
idrocarburi aromatici

derivati di-sostituiti



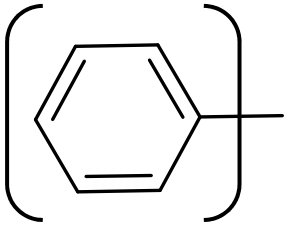
4-bromo-1-cloro-2-nitro-benzene

quando più sostituenti, sostituenti in ordine alfabetico, numerandoli in modo da ottenere cifre più basse possibile

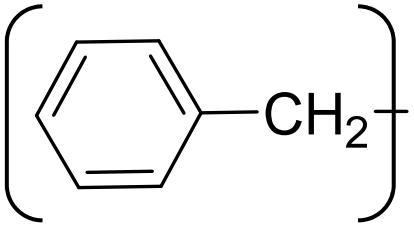


2,4,6-tri-nitro-toluene (TNT)

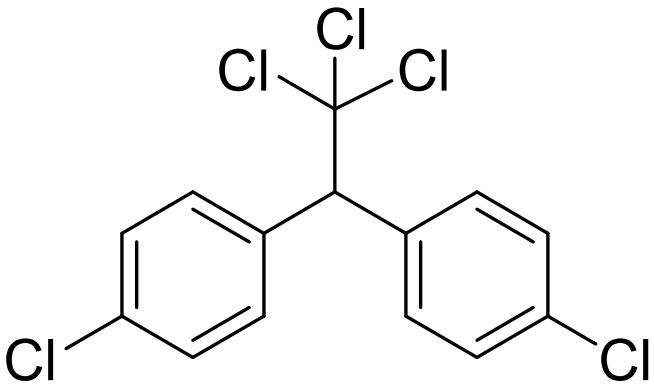
sostituenti arilici



fenile



benzile

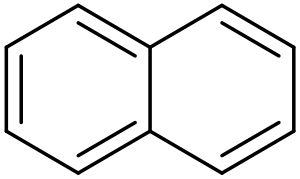


1,1,1-tricloro-2,2-bis(p-clorofenil)etano

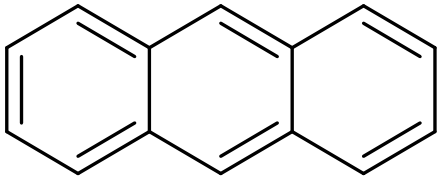
(dicloro difenil tricloroetano – DDT)

idrocarburi aromatici policiclici

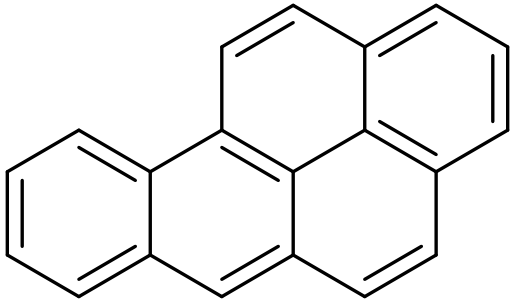
(PAH)



naftalene

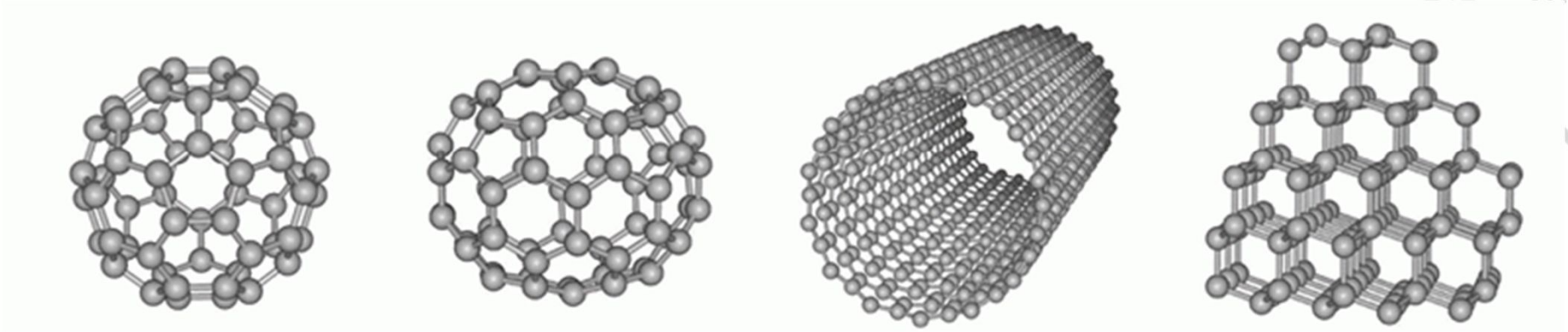


antracene



benzo[a]pirene

nanostrutture di carbonio

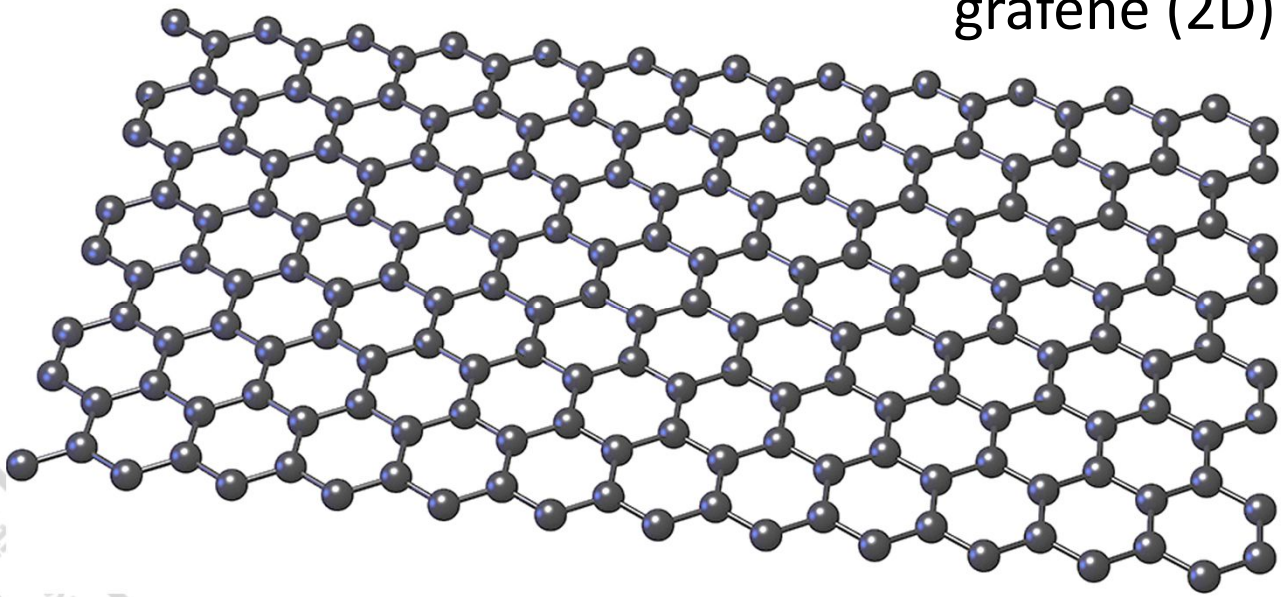


fullereni (0D)

nano-tubi (1D)

nano-diamanti (0D)

grafene (2D)



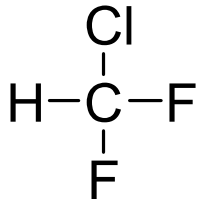
composti organici

*(composti di carbonio,
idrogeno ed altri elementi)*

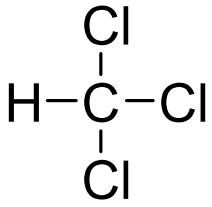
C, H + O, N, alogeni, etc.

*ENORME
varietà*

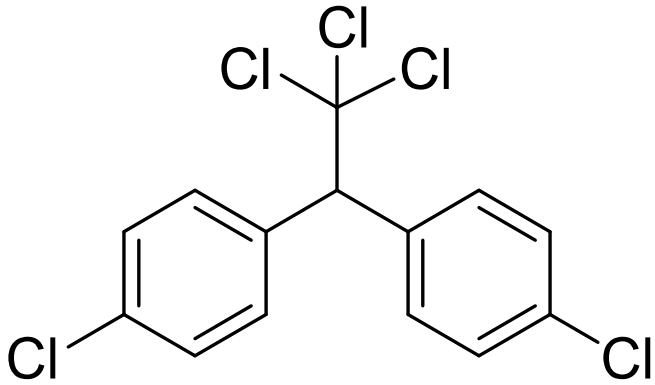
alogenuri alchilici ed arilici



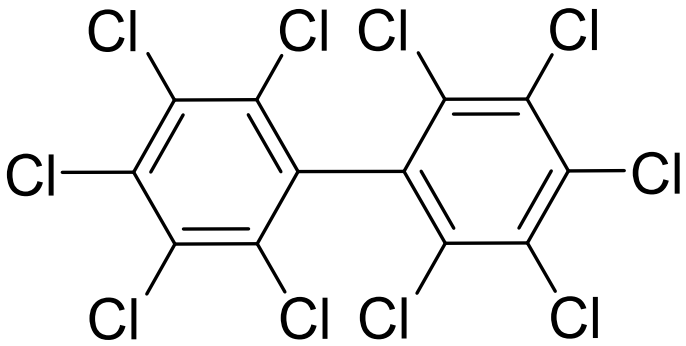
(cloro-difluoro-metano)



(cloroformio)



(DDT)

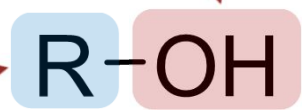


(caso Caffaro a Brescia)

policloro-bifenili (PCB)

alcoli

gruppo funzionale

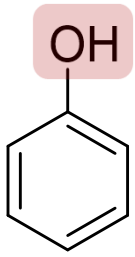


'R' indica un generico gruppo alchilico/arilico

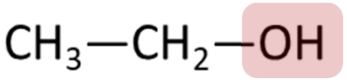
nomenclatura

(n° carboni) **-olo**

(aromatici) (alifatici)

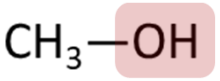


fenolo

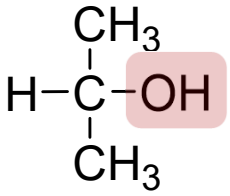


etanolo

(primari) (secondari)

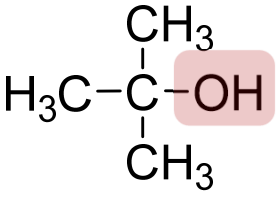


metanolo



isopropanolo (alcol isopropilico)

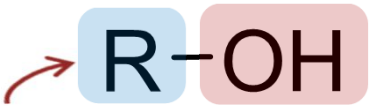
(terziari)



2-metil-2-propanolo

(poli-)alcoli (o polioli)

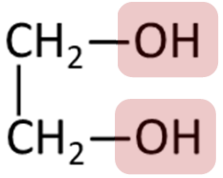
nomenclatura



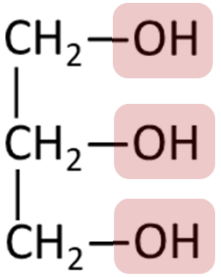
'R' indica un generico gruppo alchilico/arilico

(n° carboni) -olo

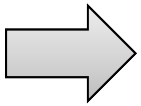
preceduto da –di, –tri, –tetra, etc.

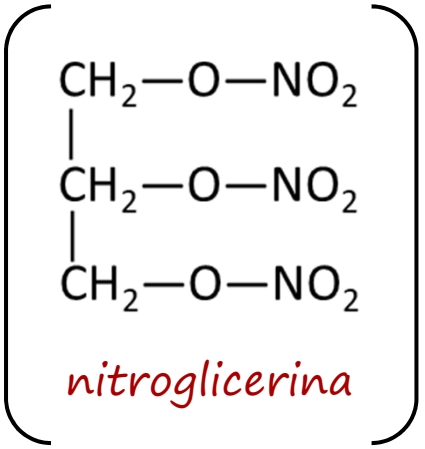


1,2-etan-diolo
(glicole etilenico)



1,2,3-propan-triolo
(glicerolo; glicerina)

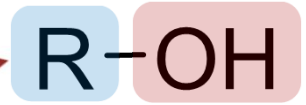




nitroglicerina

(poli-)alcoli (o polioli)

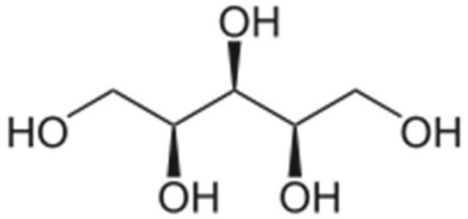
nomenclatura



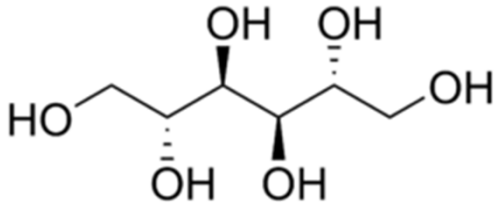
'R' indica un generico gruppo alchilico/arilico

(n° carboni) -olo

preceduto da –di, –tri, –tetra, etc.



xilitolo



mannitolo

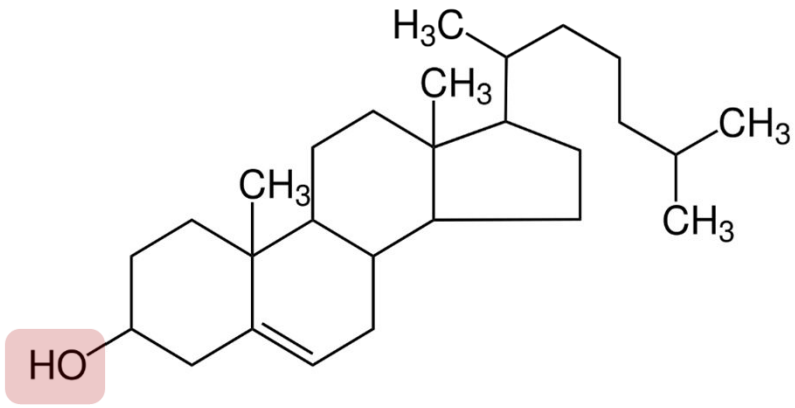
uso come dolcificanti

alcoli

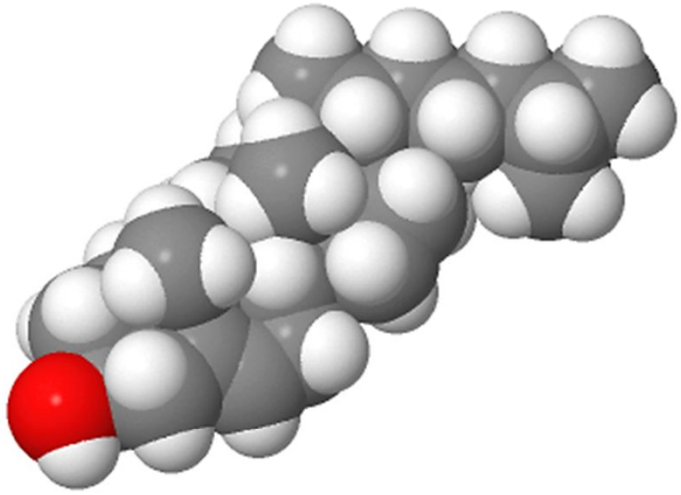
nomenclatura

R–OH

(n° carboni) -**olo**



colesterolo



eteri

nomenclatura

R_1-O-R_2 | *(nome R_1 - nome R_2)* **etere**

$CH_3-CH_2-O-CH_2-CH_3$

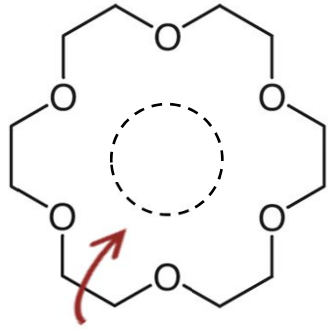
dietil-etere
(etere di-etilico)

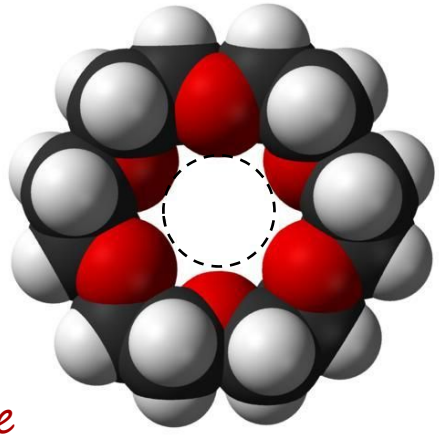
etano *etossi-*

$CH_3-CH_2-O-CH_2-CH_3$

etossi-etano
(IUPAC)

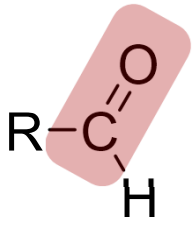
eteri corona



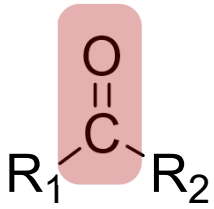


spazio per ospitare ione metallico

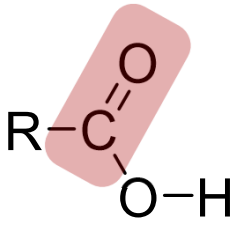
composti carbonilici



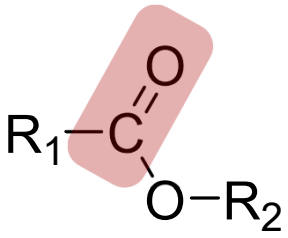
aldeidi



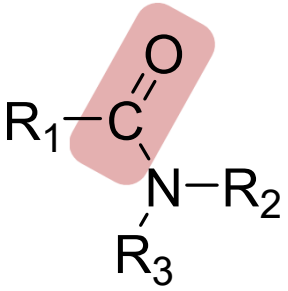
chetoni



acidi carbossilici



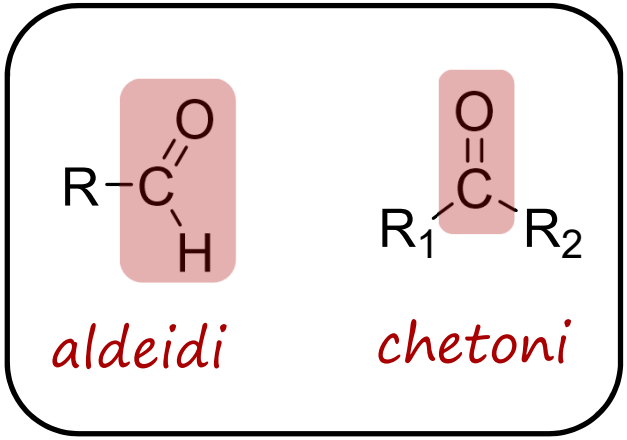
esteri



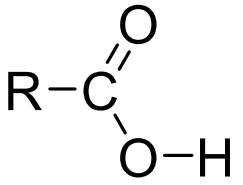
ammidi

tutti caratterizzati dal doppio legame C=O

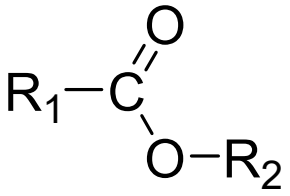
composti carbonilici



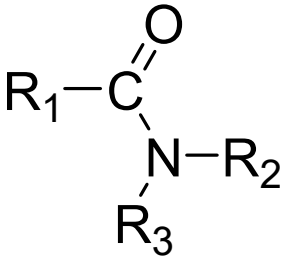
aldeidi chetoni



acidi carbossilici



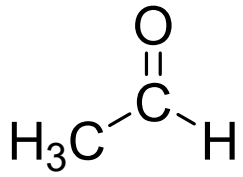
esteri



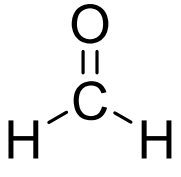
ammidi

nomenclatura

(n° carboni) - ale



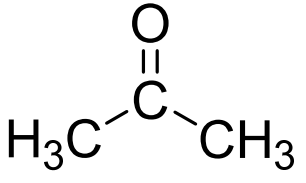
etanale (acetaldeide)



metanale (formaldeide)

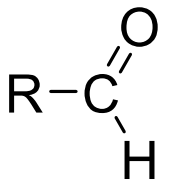
nomenclatura

(n° carboni) - one

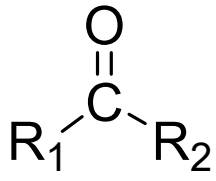


propanone (acetone, dimetilchetone)

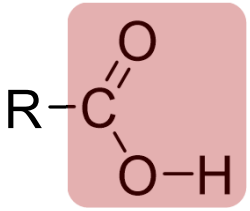
composti carbonilici



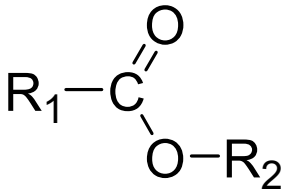
aldeidi



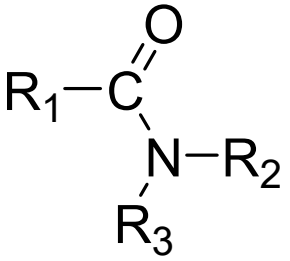
chetoni



acidi carbossilici



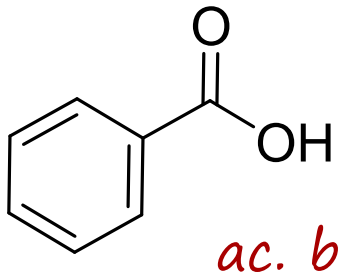
esteri



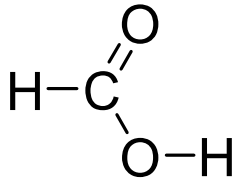
ammidi

nomenclatura

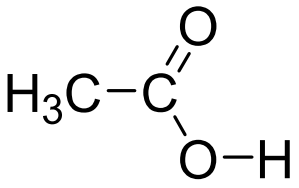
acido *(n° carboni)* - **oico**



ac. benzoico

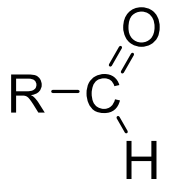


ac. metanoico
(ac. formico)

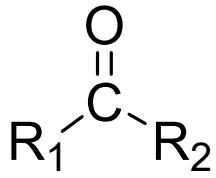


ac. etanoico
(ac. acetico)

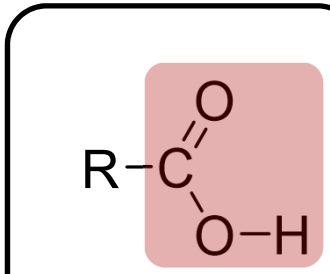
composti carbonilici



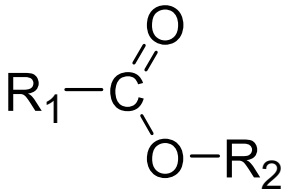
aldeidi



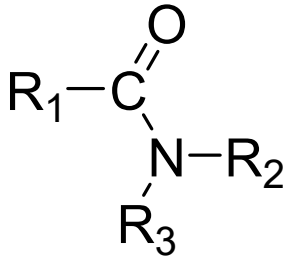
chetoni



acidi carbossilici



esteri

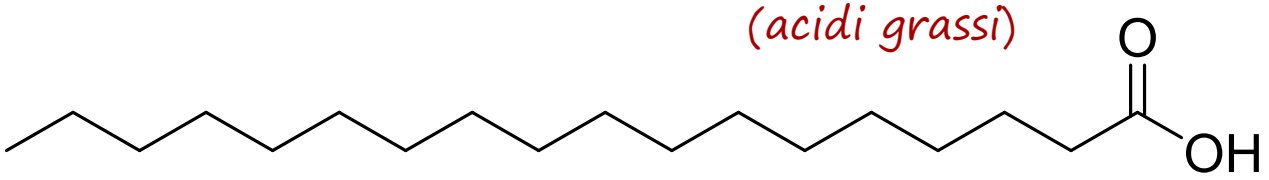


ammidi

nomenclatura

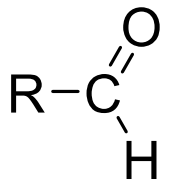
acido *(n° carboni)* - **oico**

(acidi grassi)

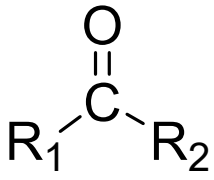


ac. octadecanoico
(ac. stearico)

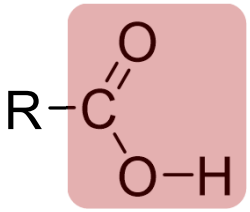
composti carbonilici



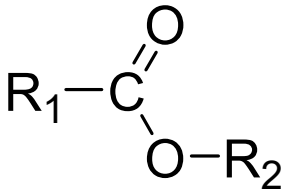
aldeidi



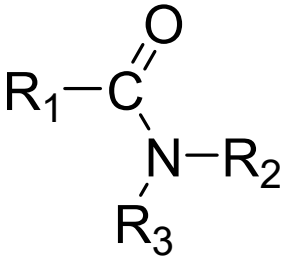
chetoni



acidi carbossilici



esteri

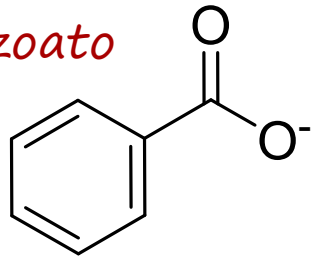


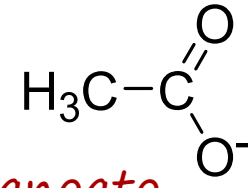
ammidi

nomenclatura

(n° carboni) - **oato**

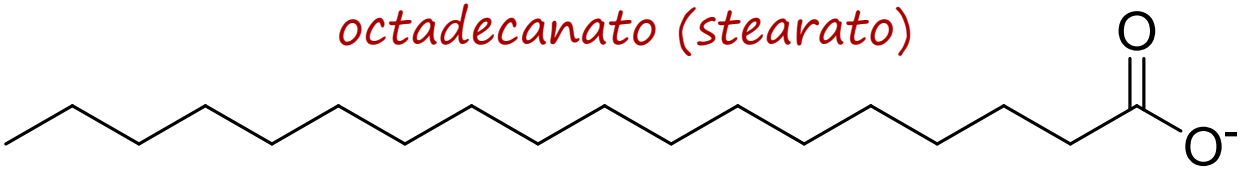
benzoato



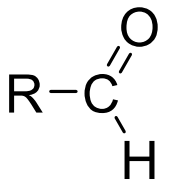


etanoato (acetate)

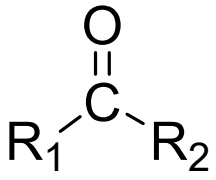
octadecanato (stearato)



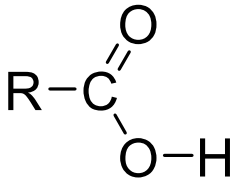
composti carbonilici



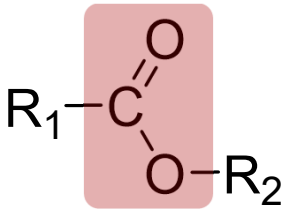
aldeidi



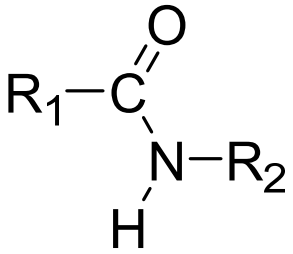
chetoni



acidi carbossilici



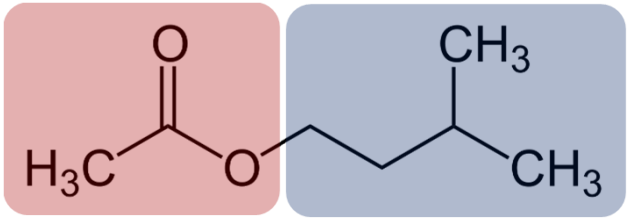
esteri



ammidi

nomenclatura

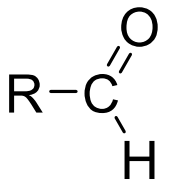
(n° carboni) - **ato** di *(residuo alchilico/arilico)*



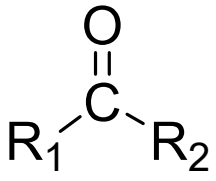
etanoato (acetato) di isopentile

(odori gradevoli, aromi della frutta)

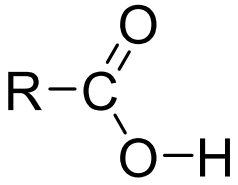
composti carbonilici



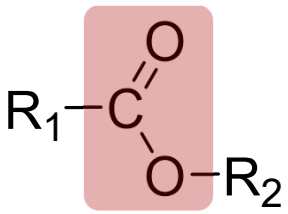
aldeidi



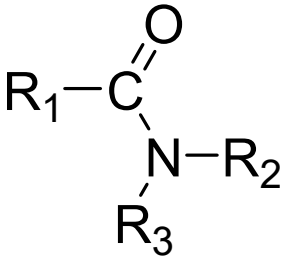
chetoni



acidi carbossilici



esteri

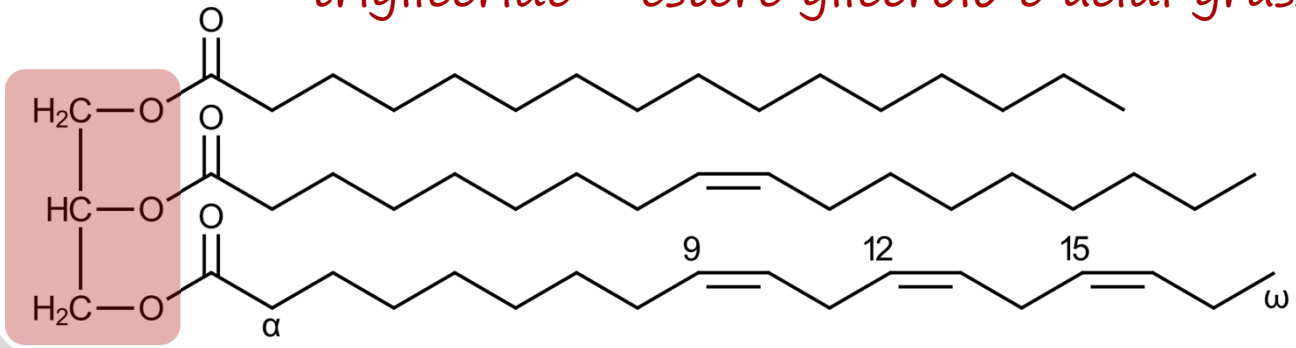


ammidi

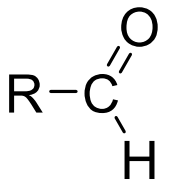
nomenclatura

(n° carboni) - **ato** di *(residuo alchilico/arilico)*

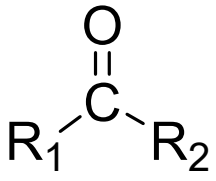
trigliceride = estere glicerolo e acidi grassi



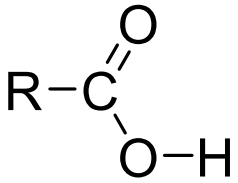
composti carbonilici



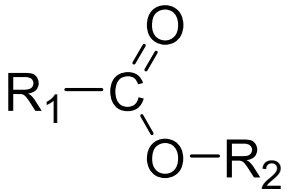
aldeidi



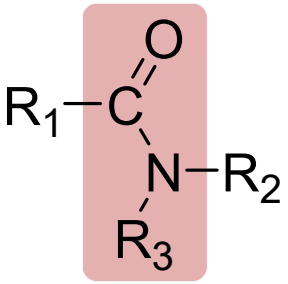
chetoni



acidi carbossilici



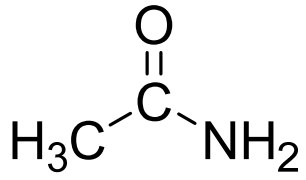
esteri



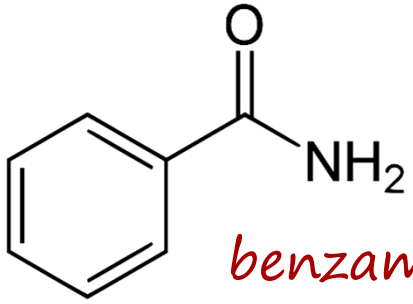
ammidi

nomenclatura

(n° carboni) - **ammide**



etanammide

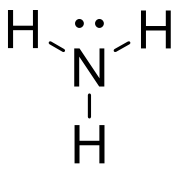


benzammide

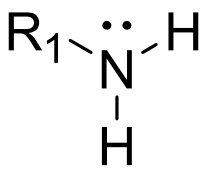
ammine

nomenclatura

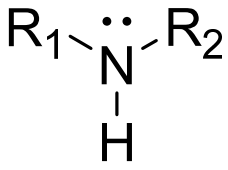
(n° carboni) -**ammina**



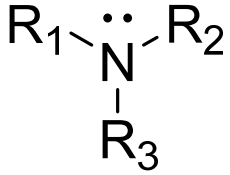
ammoniaca



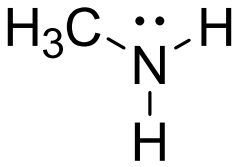
ammina primaria



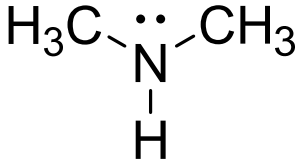
ammina secondaria



ammina terziaria



metilammina

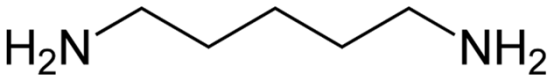


dimetilammina

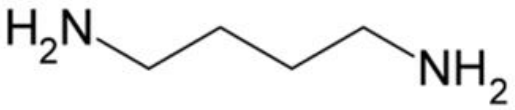
ammine

nomenclatura

(n° carboni) -**ammina**



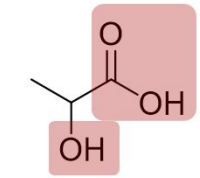
cadaverina



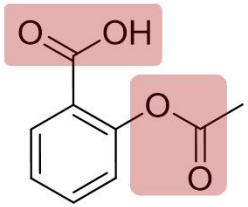
putrescina

odori sgradevoli

composti con più gruppi funzionali

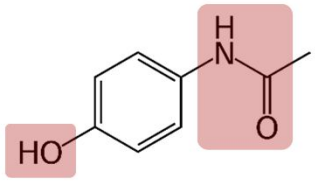


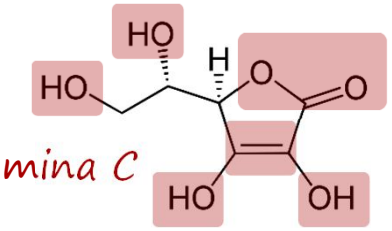
acido lattico



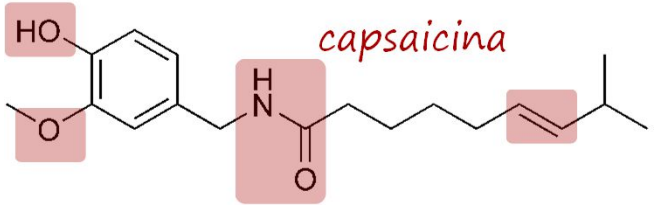
aspirina

paracetamolo

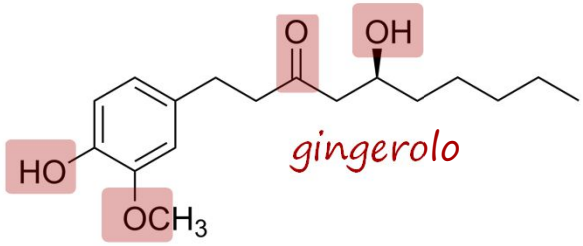




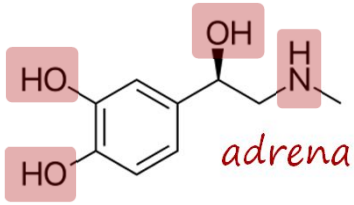
vitamina C



capsaicina



gingerolo



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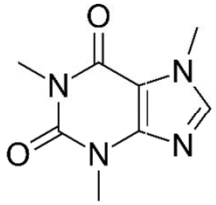
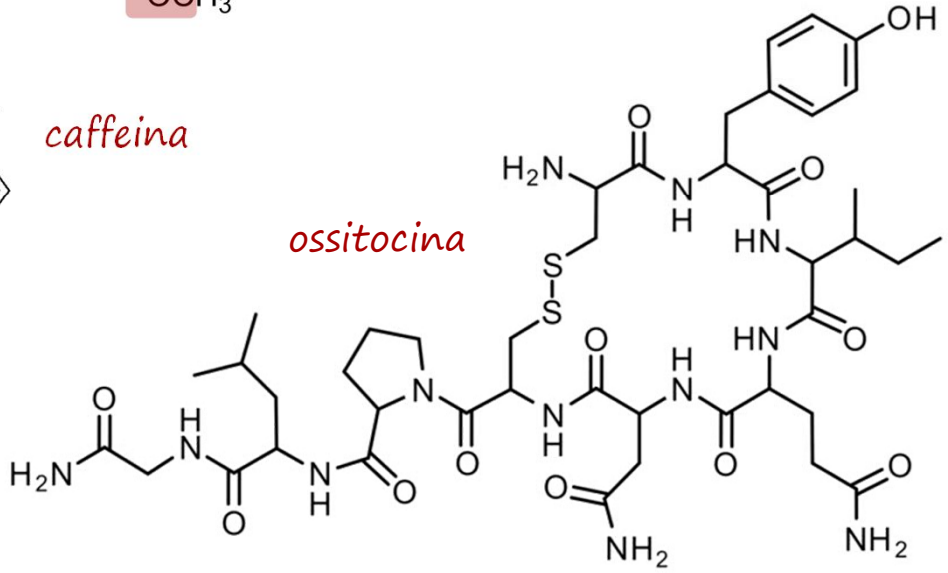
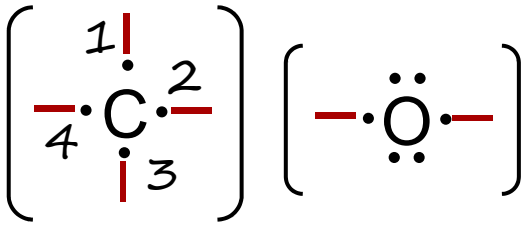


caffeina

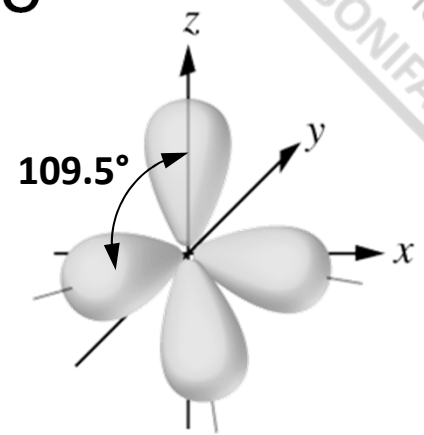


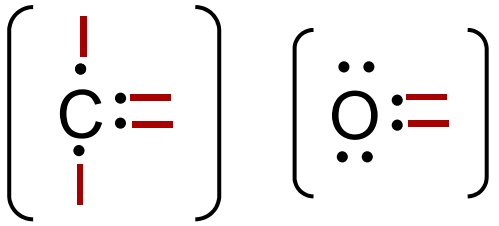
ossitocina

VBT e composti del carbonio

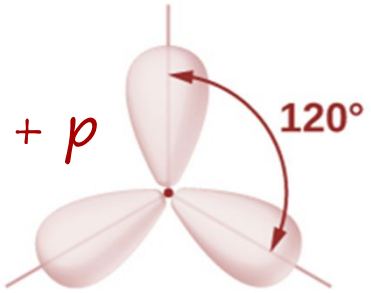


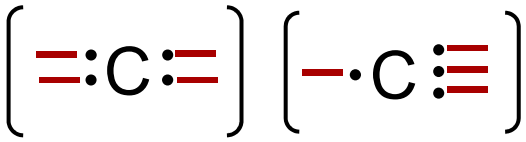
4 gruppi di coppie elettroniche



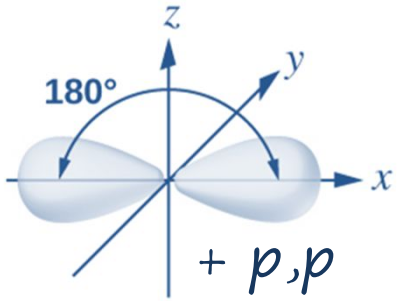


3 gruppi di coppie elettroniche



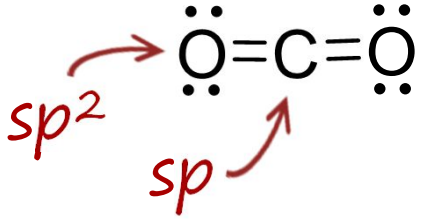


2 gruppi di coppie elettroniche

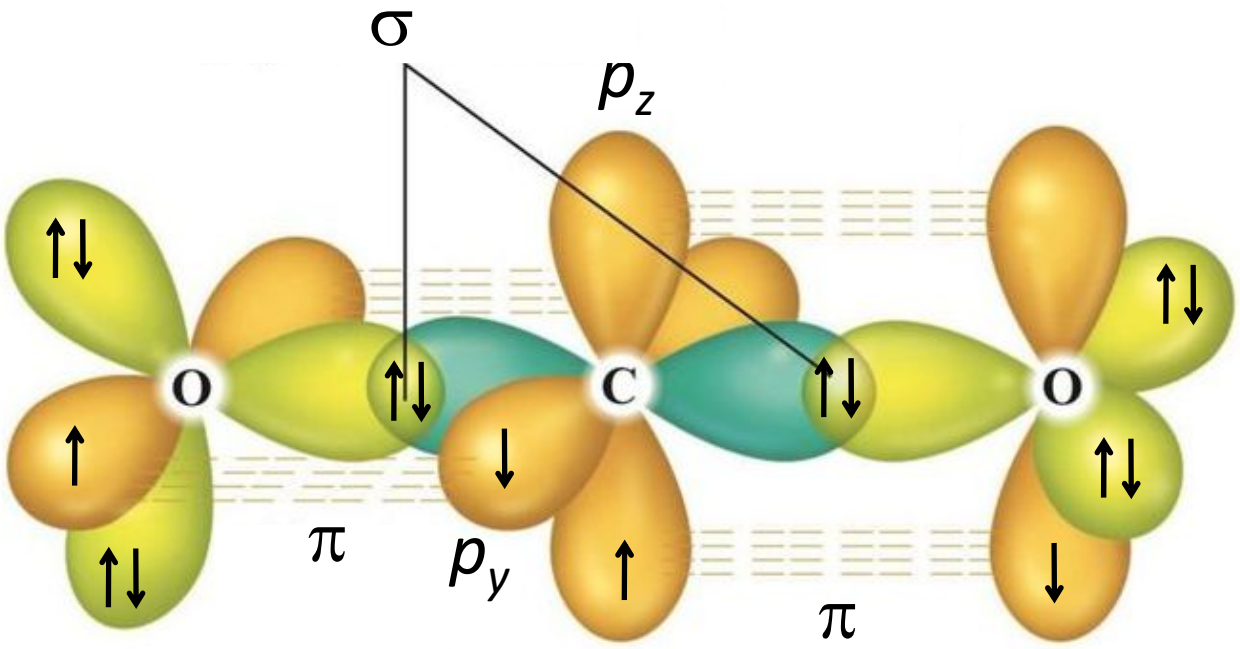


N.B. per ogni legami multiplo, devo avere elettroni p liberi

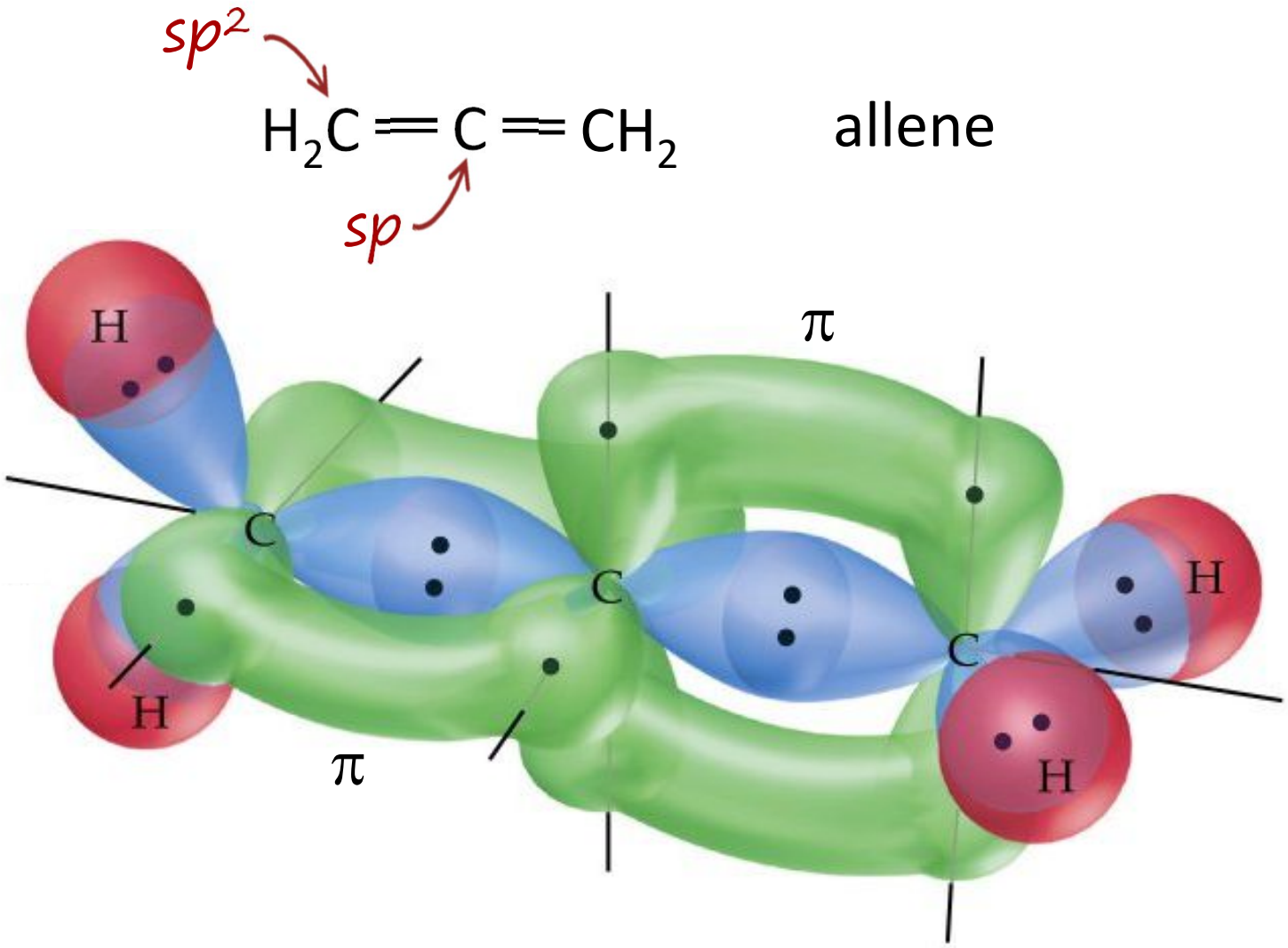
VBT e composti del carbonio



anidride carbonica

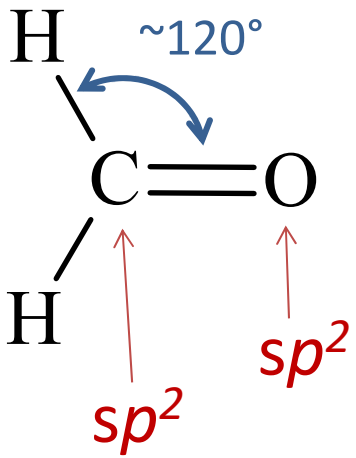


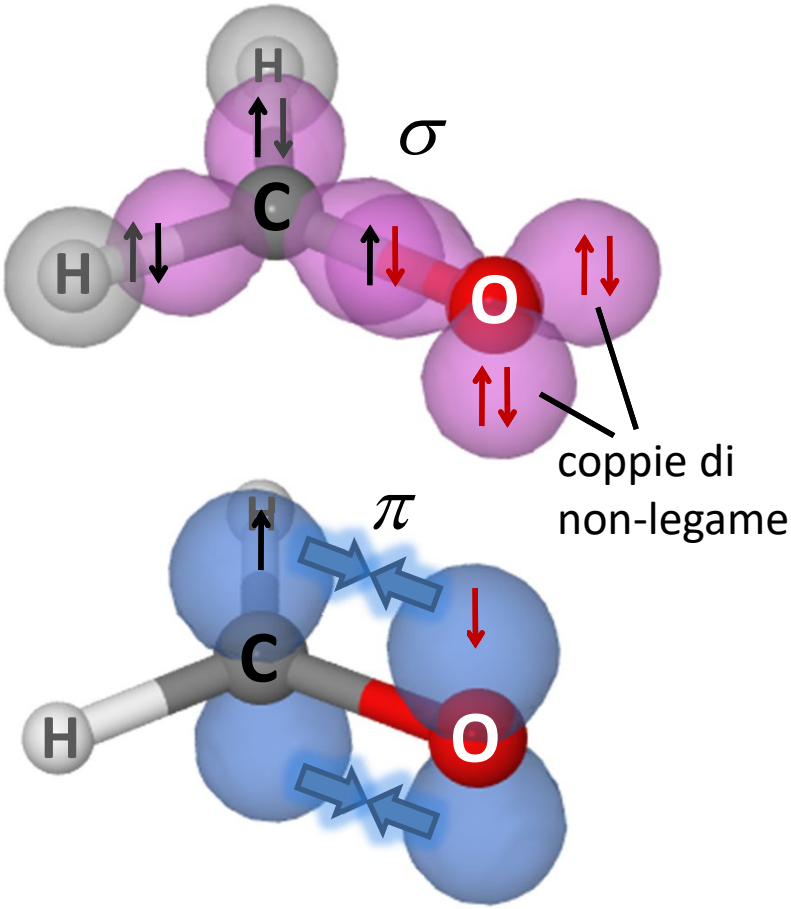
VBT e composti del carbonio

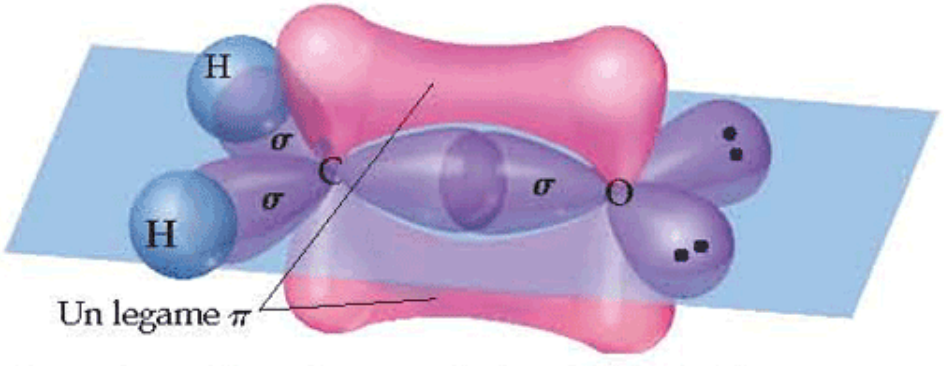


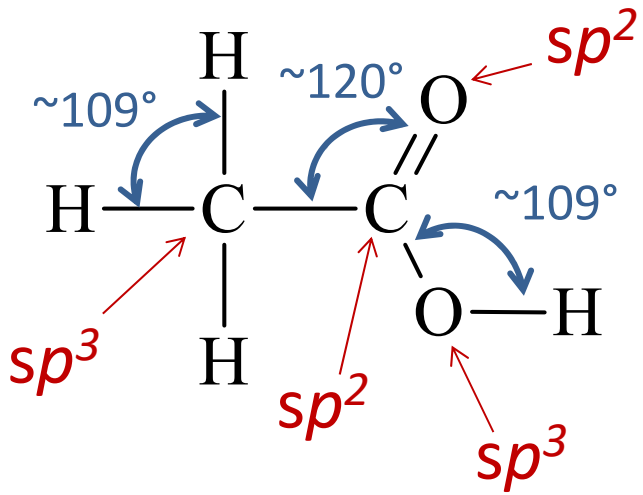
VBT e composti del carbonio

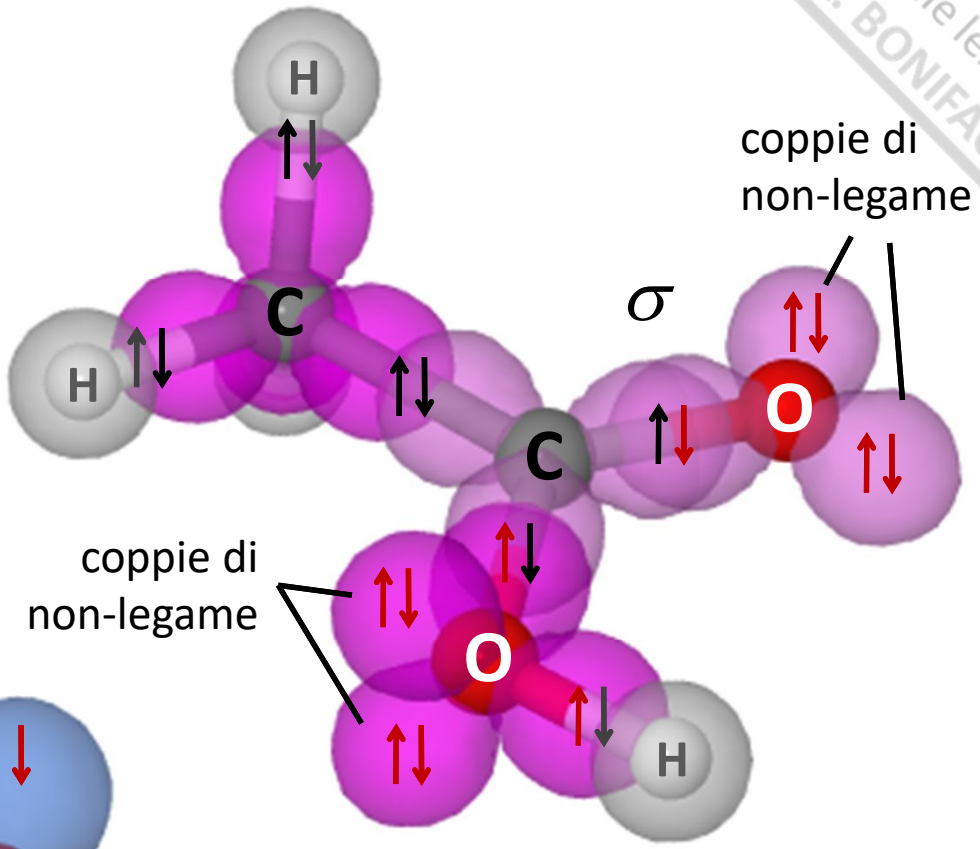
formaldeide CH_2O

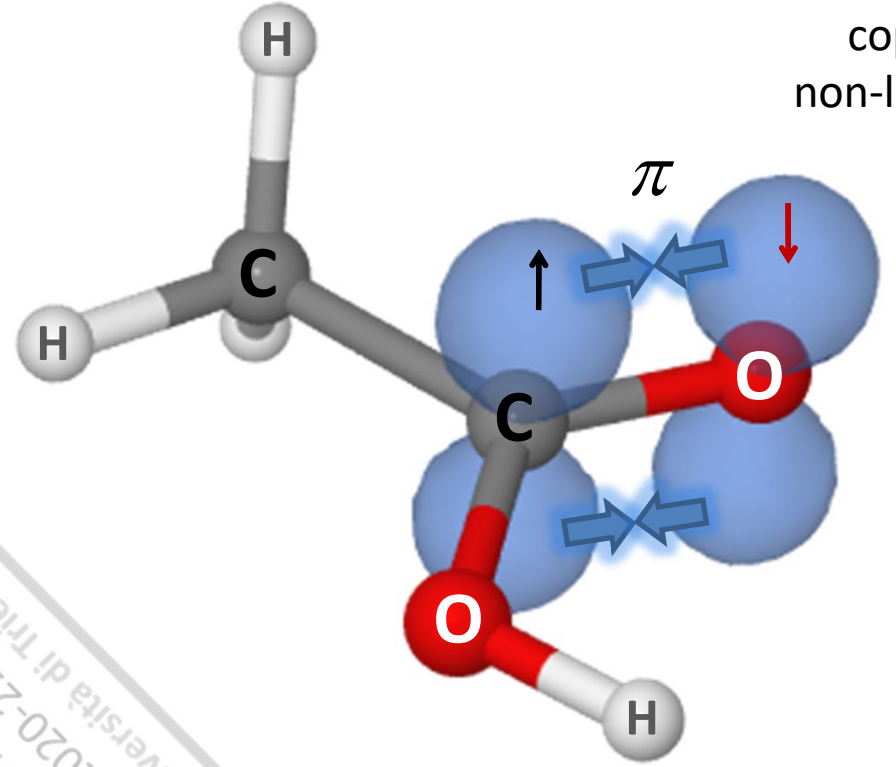












acido acetico

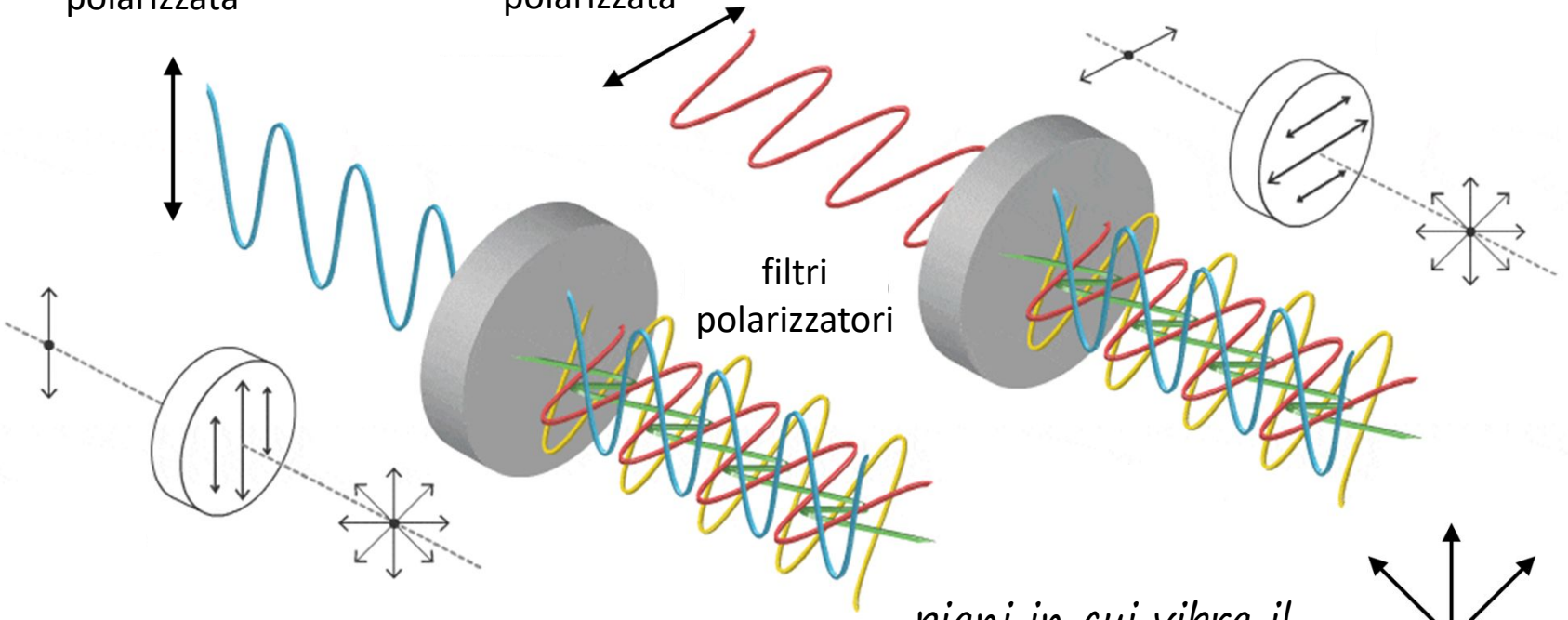
CH_3COOH

polarizzazione della luce

vibra in un solo piano

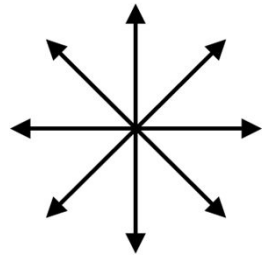
radiazione polarizzata

radiazione polarizzata



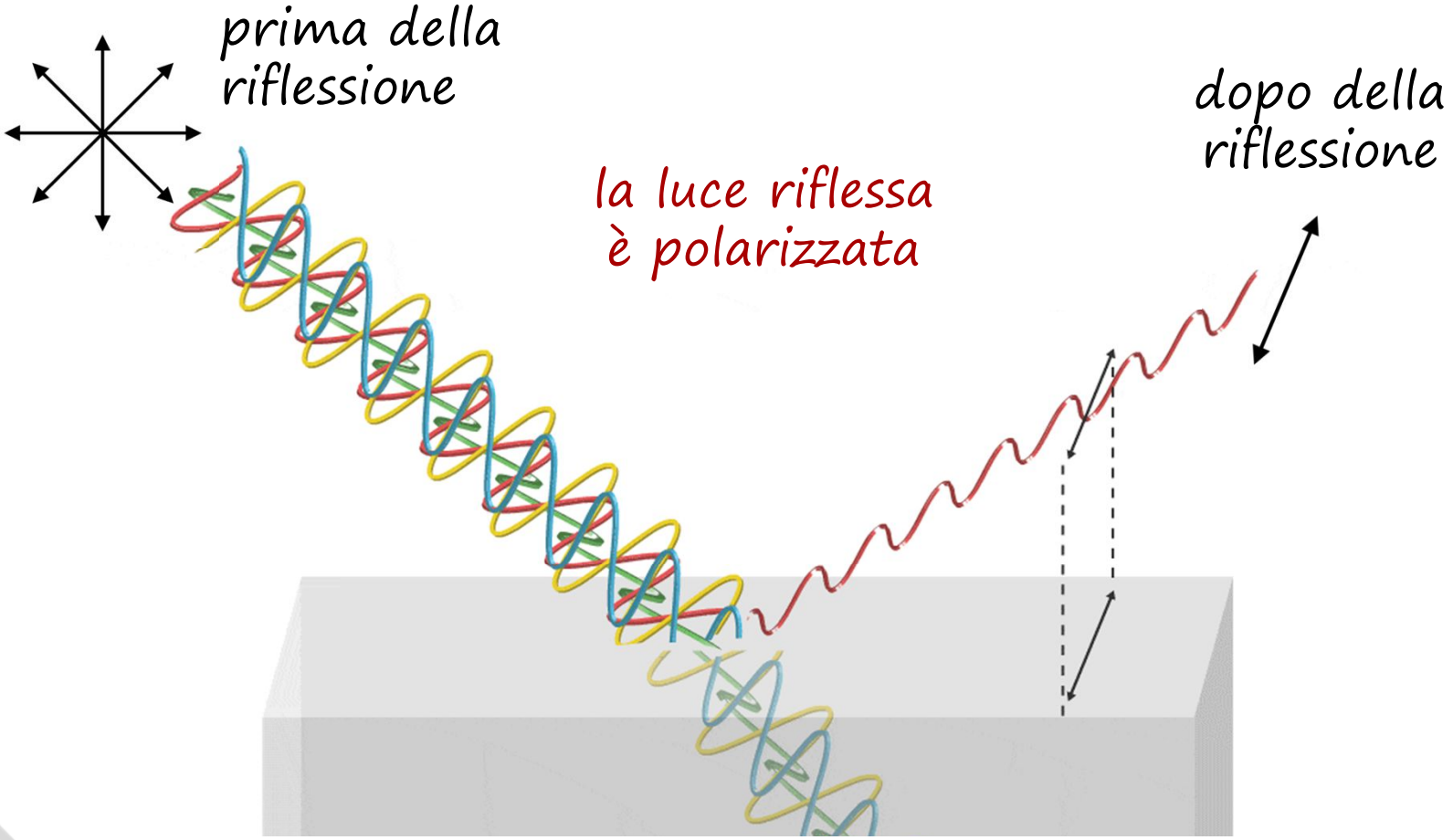
filtri polarizzatori

piani in cui vibra il campo elettrico



radiazione NON polarizzata

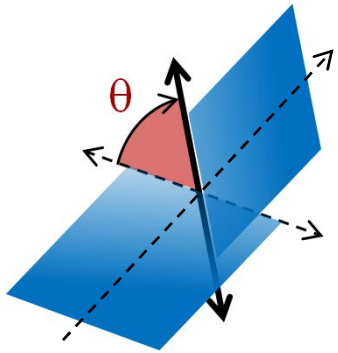
polarizzazione della luce

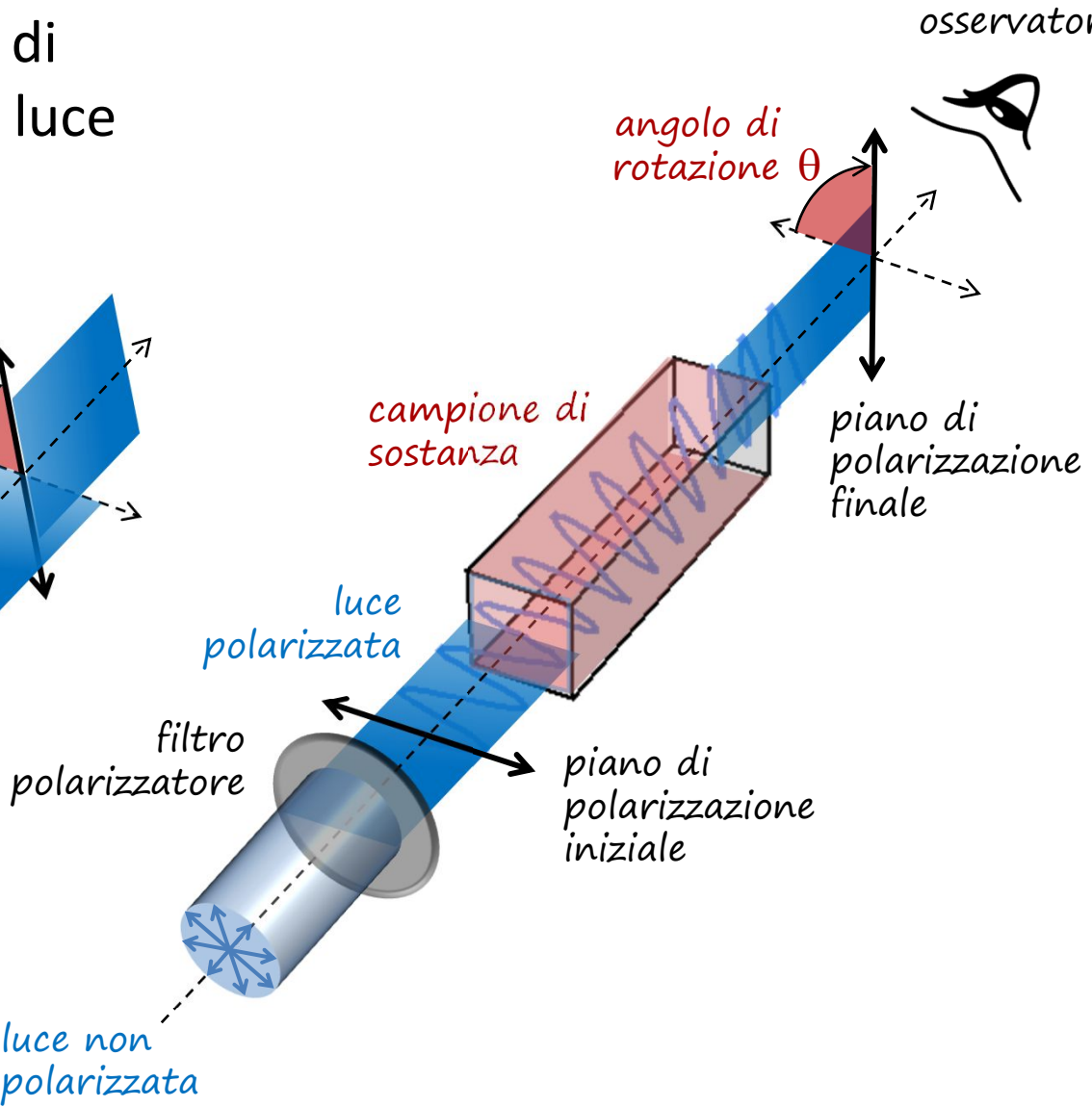


attività ottica

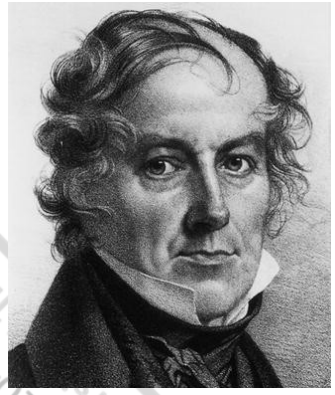
rotazione del piano di polarizzazione della luce

da parte di alcune sostanze

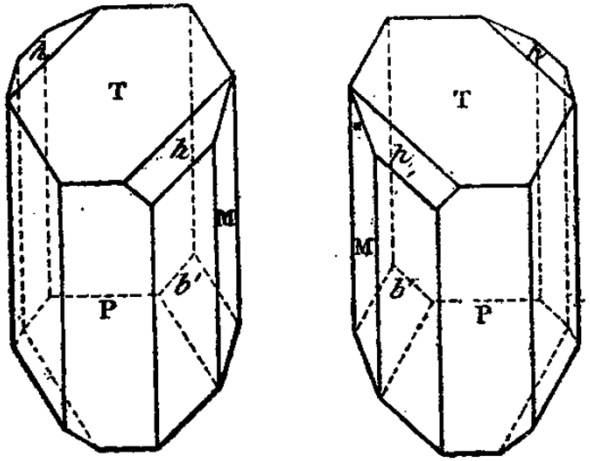




J.B. Biot



Pasteur e la scoperta dell' isomeria ottica



cristalli di acido tartarico

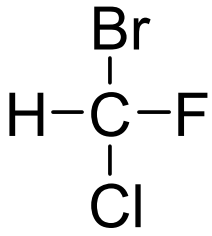
Luis Pasteur

ruotano il piano della luce polarizzata degli stessi gradi ma in versi opposti (orario ed antiorario)

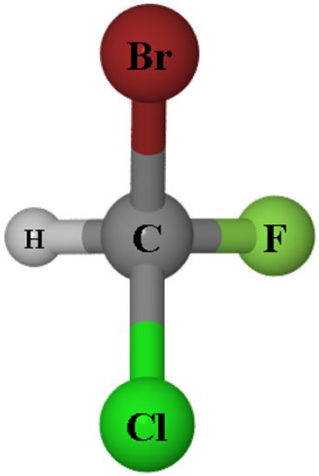
è dovuto a strutture chimiche diverse (ISOMERIA)

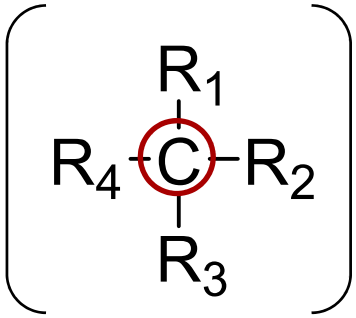
isomeria ottica

CHBrClF



(bromo-cloro-fluoro-metano)

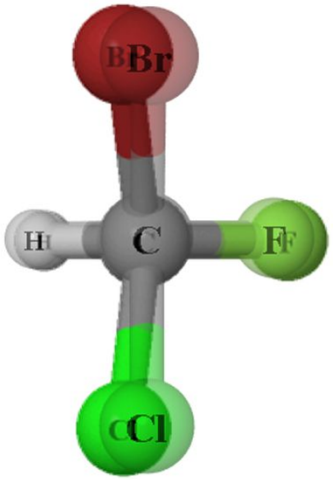


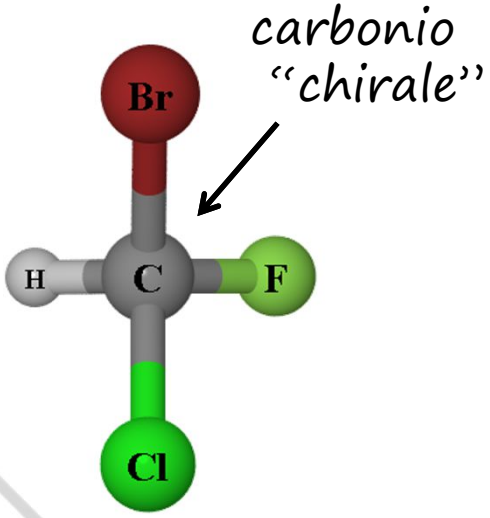


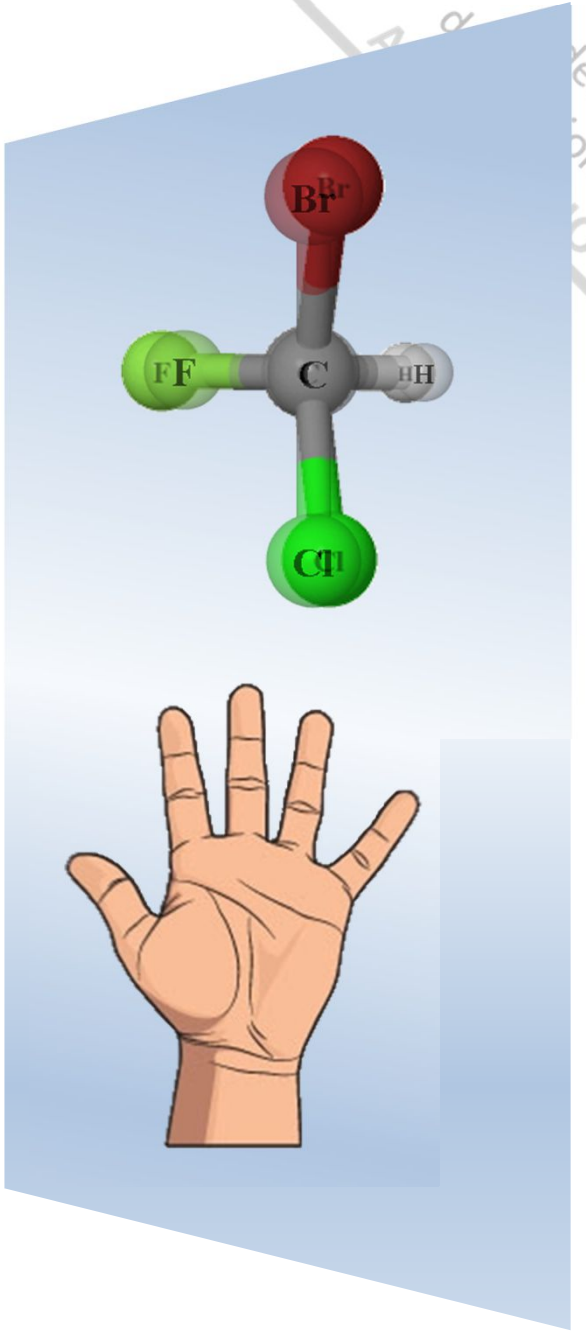
carbonio quaternario legato a 4 sostituenti diversi

isomeria ottica

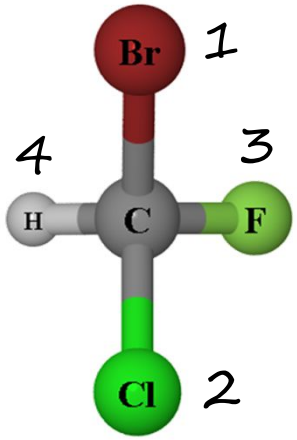
2 forme possibli
enantiomeri



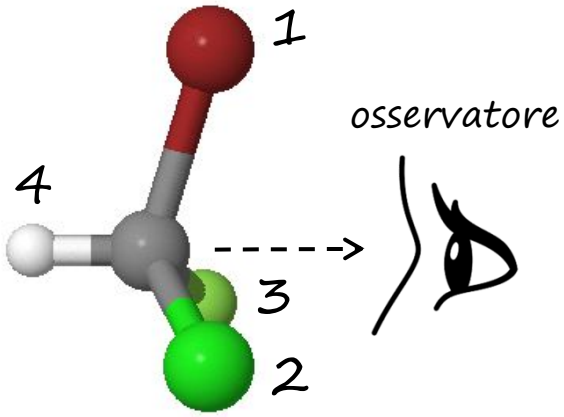




isomeria ottica (nomenclatura Cahn-Ingold-Prelog)



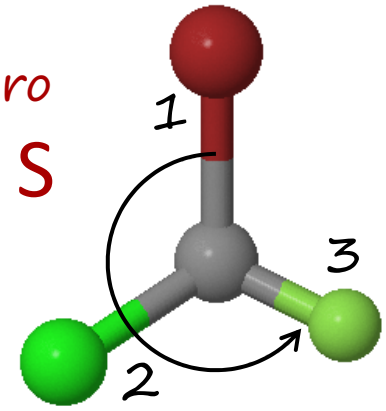
1. numera sostituenti in ordine decrescente di numero atomico



2. disporre sostituente con numero più basso opposto all'osservatore

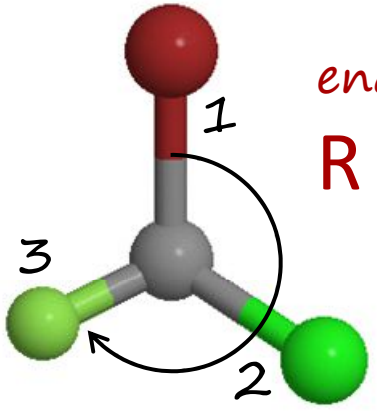
enantiomero

(lat. *Sinister*) S



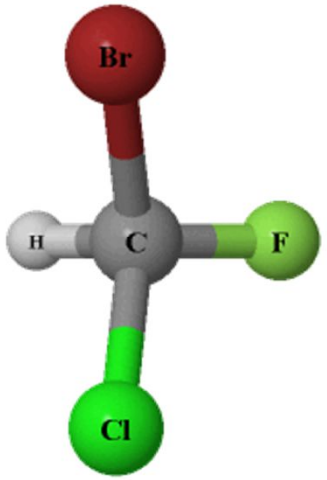
enantiomero

R (lat. *Rectus*)

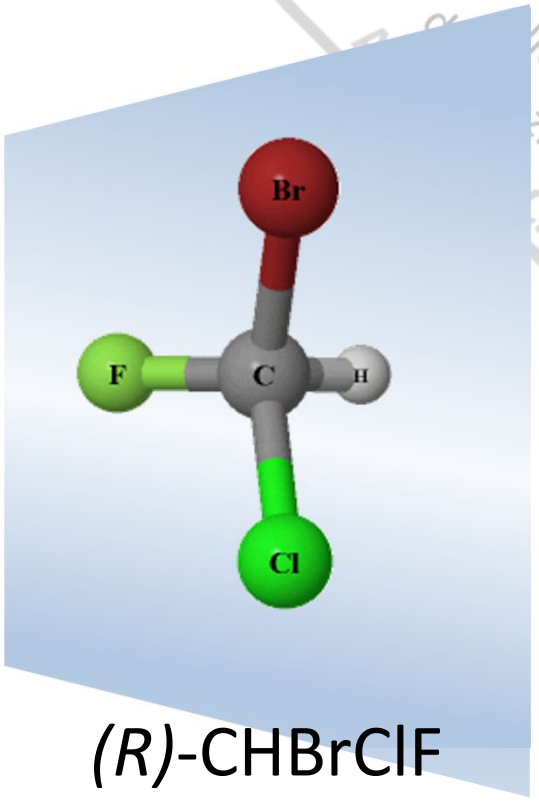


isomeria ottica

2 forme possibli
enantiomeri



(S)-CHBrClF



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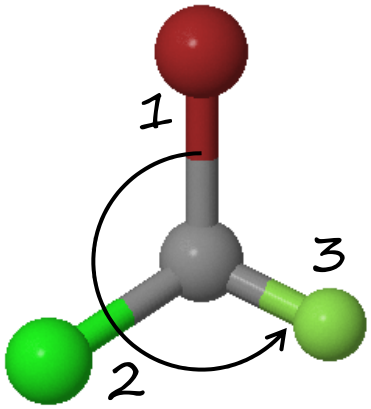
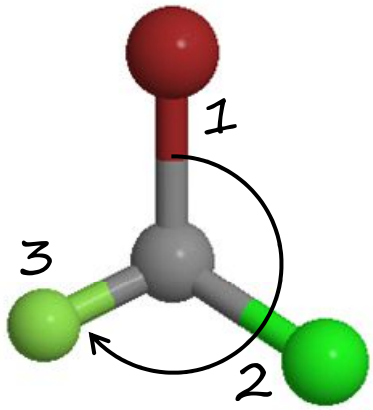
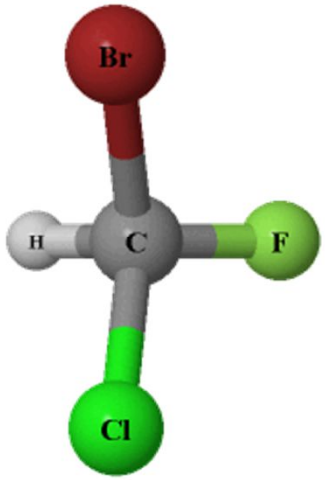




isomeria ottica

2 forme possibli
enantiomeri



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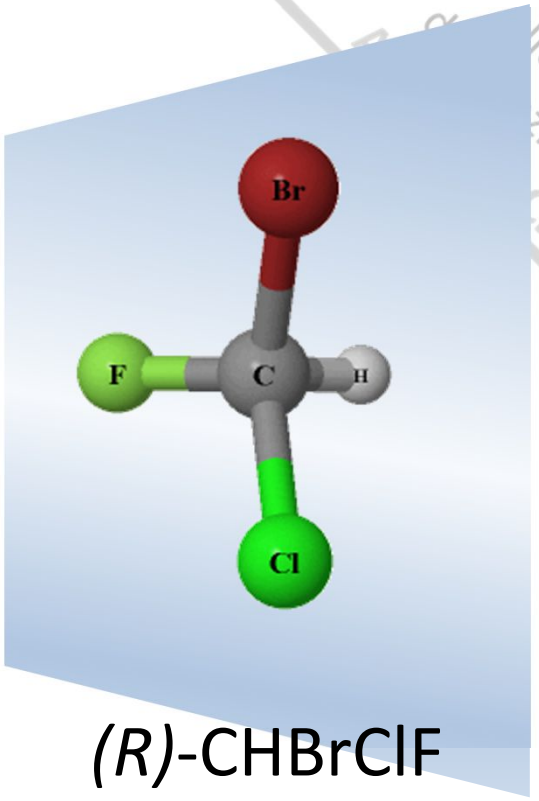

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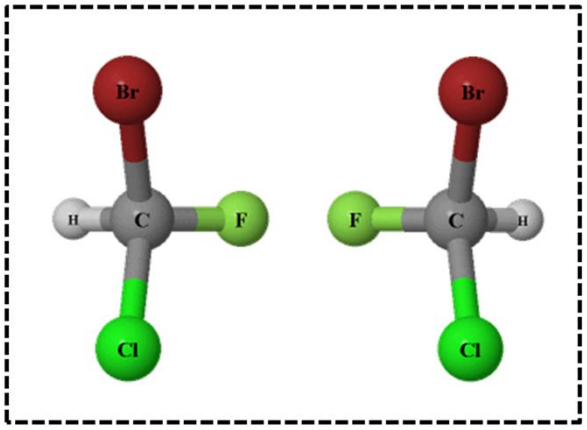
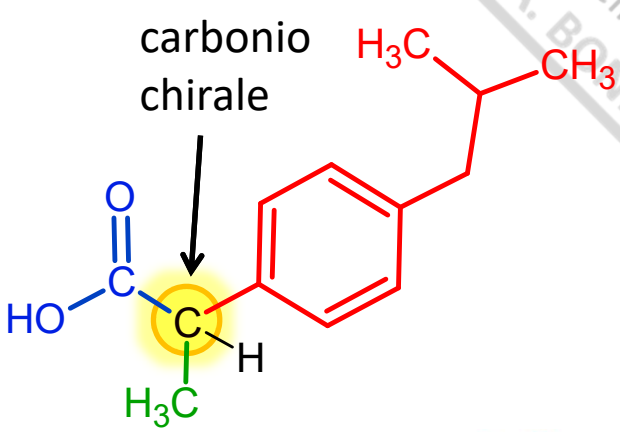
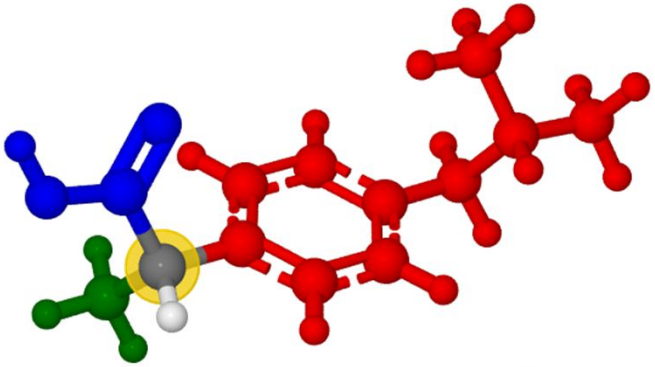
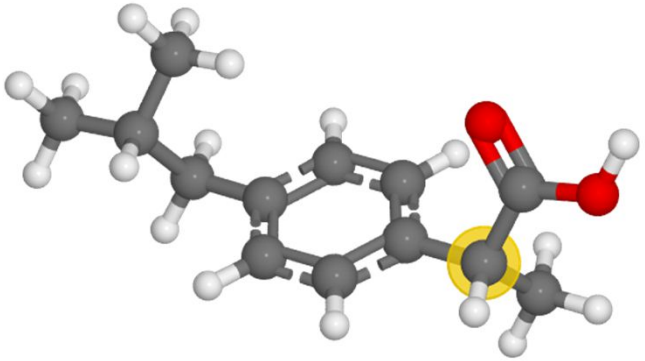


quando presenti
entrambe le forme:
'racemo'

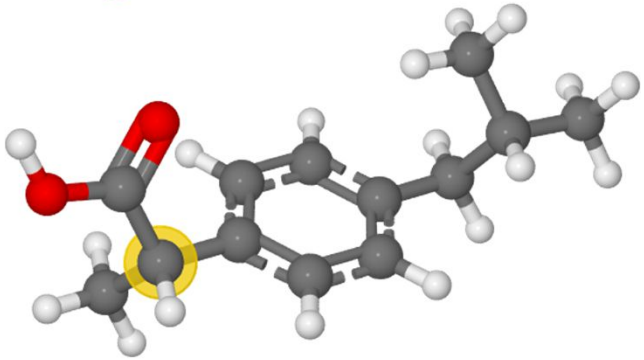
ibuprofene





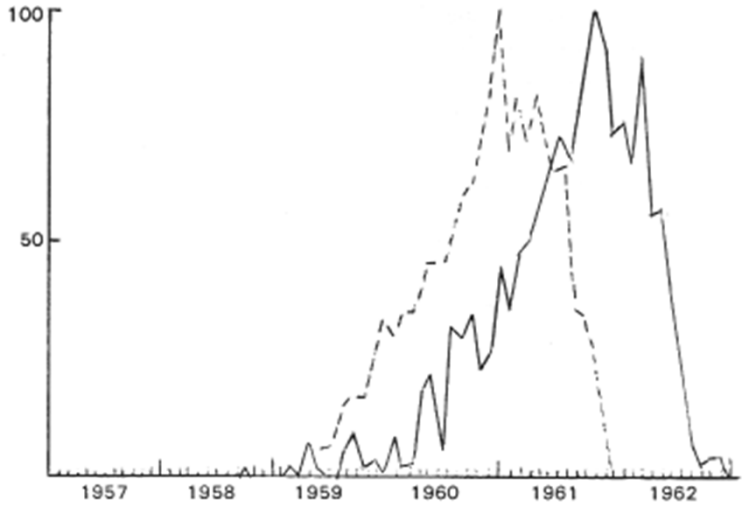


enantiomero non attivo
(*R*)-(-)-ibuprofene



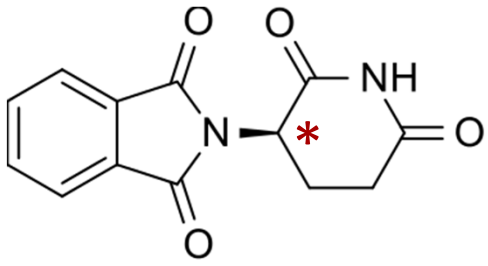
enantiomero attivo
(*S*)-(+)-ibuprofene

il caso della talidomide



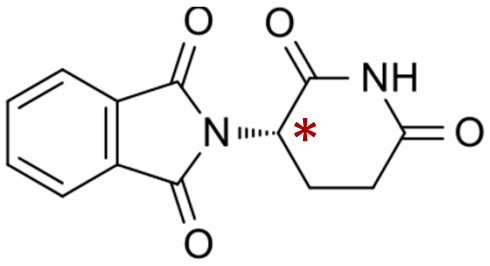
Graph showing the relation between the malformations of the thalidomide type and the sales of thalidomide (figures for Germany excluding Hamburg).

– – – Thalidomide sales (January 1961 = 100)
——— 845 abnormalities of the thalidomide type (October 1961 = 100)



(R)-thalidomide

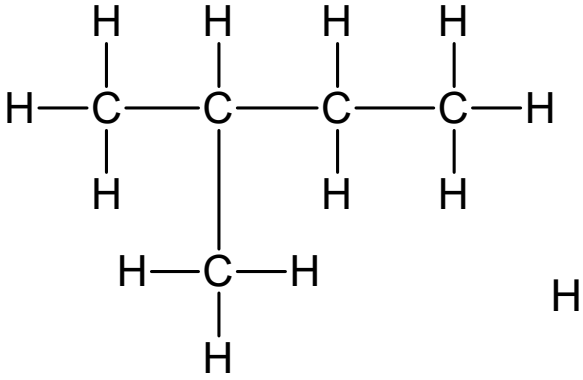
(forma attiva)



(S)-thalidomide

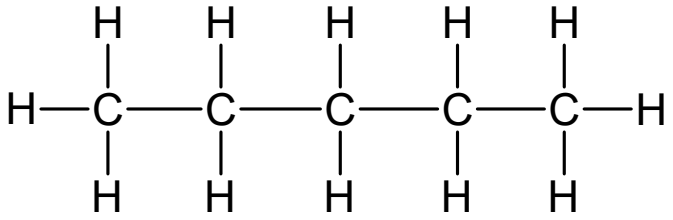
(forma teratogena)

diversi tipi di isomeria



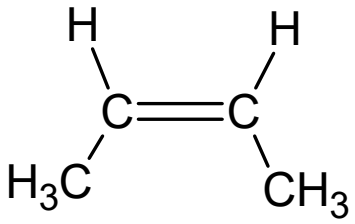
isomeria strutturale

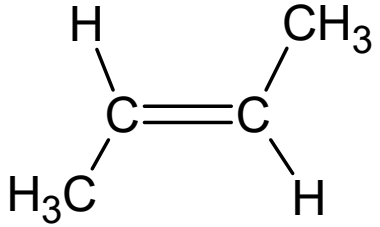
(o costituzionale)

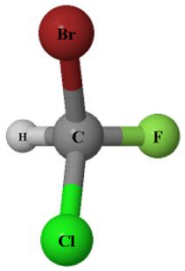


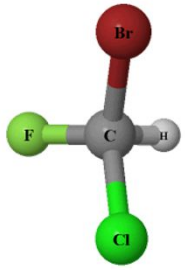
isomeria geometrica

(o cis-trans)







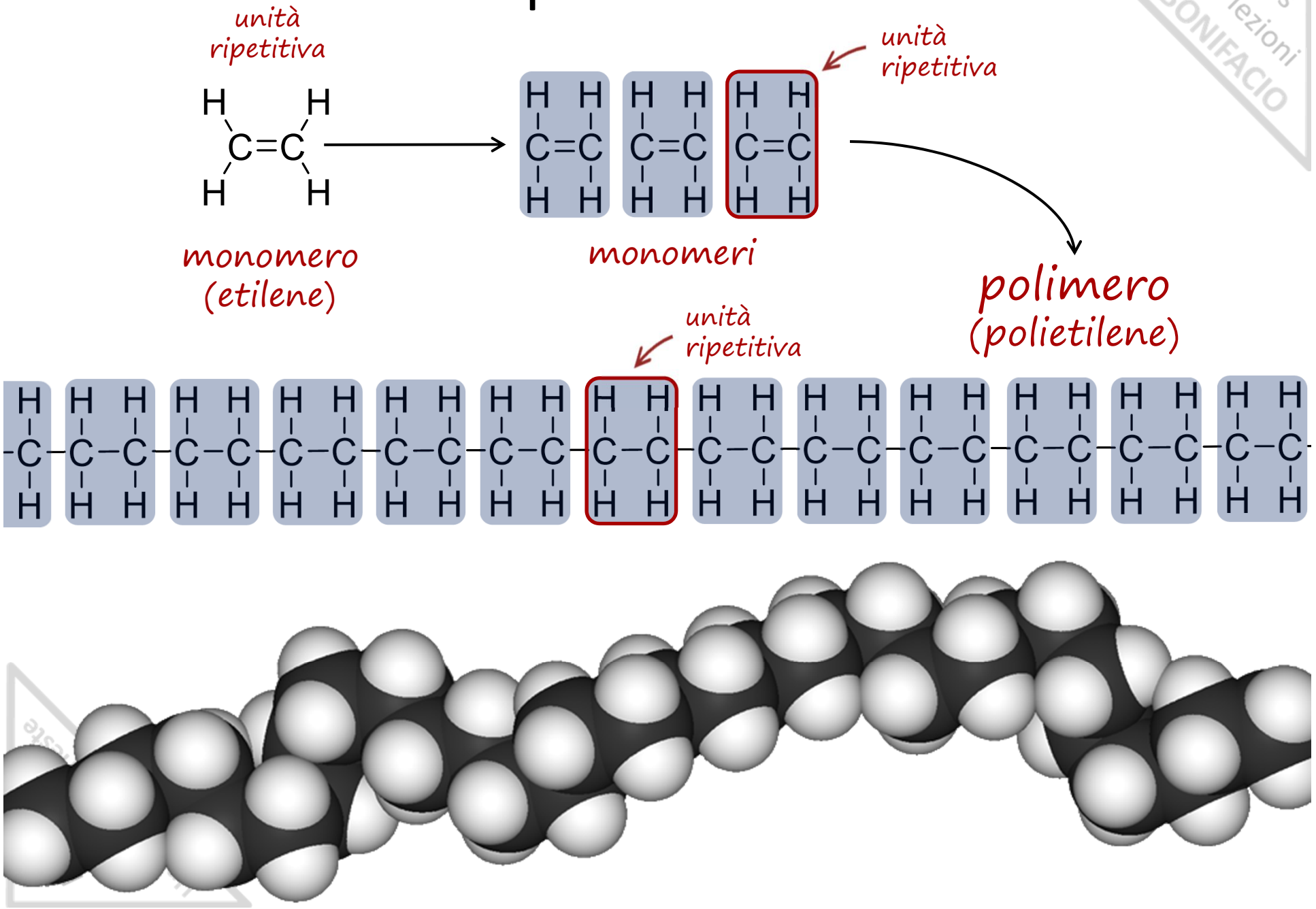


isomeria ottica

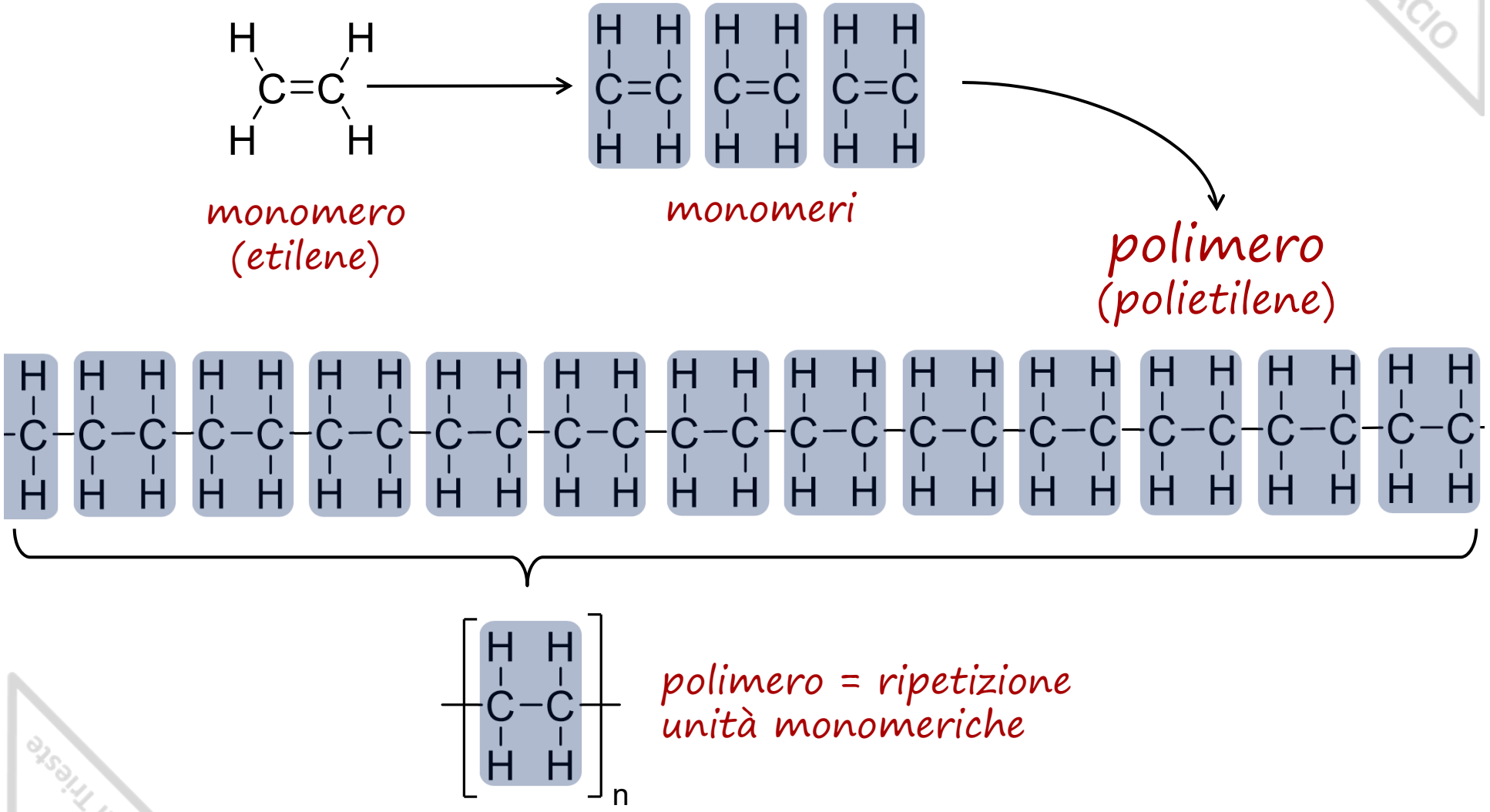
polimeri

(plastiche)

polimeri

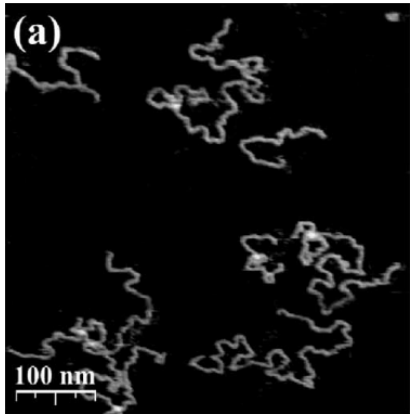


polimeri



polimeri

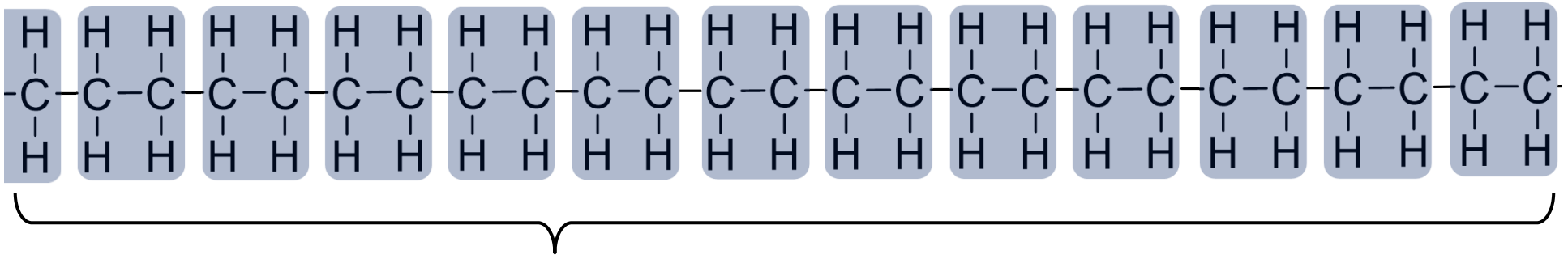
immagini AFM di polimeri

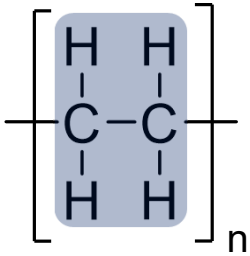


(Roiter et al Polymer 2006 47 2493)

catene anche con **200.000** unità monomeriche, con pesi fino a **6.000.000** Da

polimero (polietilene)





polimero = ripetizione unità monomeriche

polimeri - classificazione

comportamento rispetto a T

- *polimeri termoplastici*
- *polimeri termoindurenti*

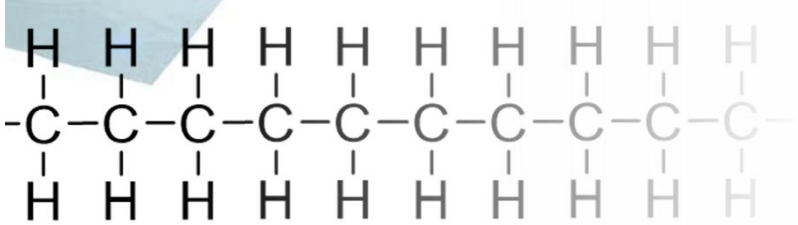
metodo di sintesi

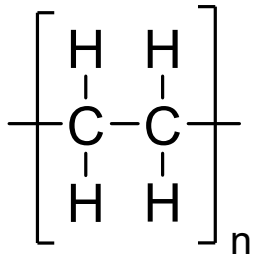
- *polimeri a crescita di catena (di addizione)*
- *polimeri di condensazione*

utilizzo

- *plastiche*
- *elastomeri (o gomme)*
- *fibre, adesivi, ...*

plastiche

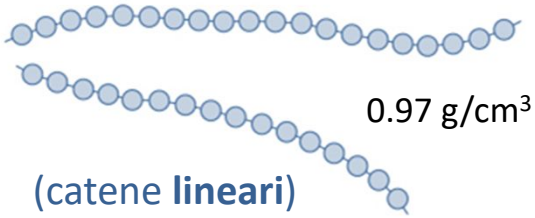




polietilene

(High Density)

HDPE

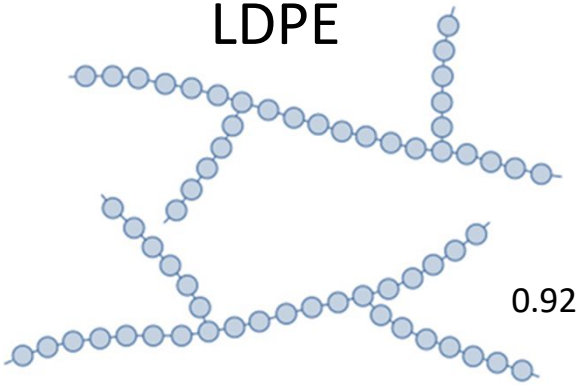


0.97 g/cm^3

(catene **lineari**)

(Low Density)

LDPE



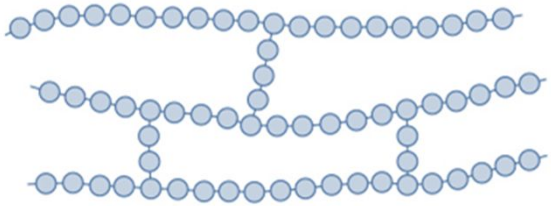
0.92 g/cm^3

(catene **ramificate**)

(Cross-Linked)

CLPE

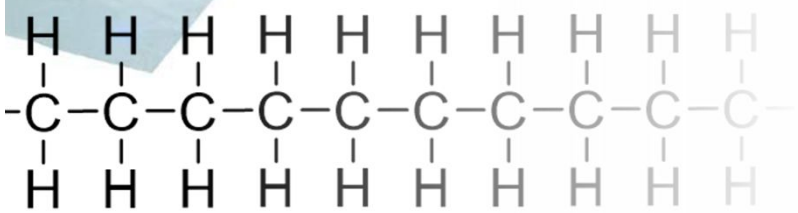
(catene **reticolate**)

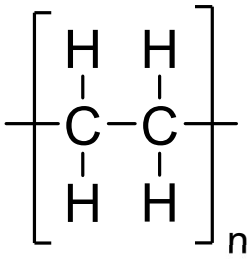


0.94 g/cm^3

proprietà dipendono da struttura

plastiche

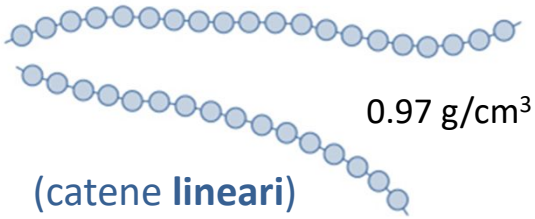




polietilene

(*High Density*)

HDPE

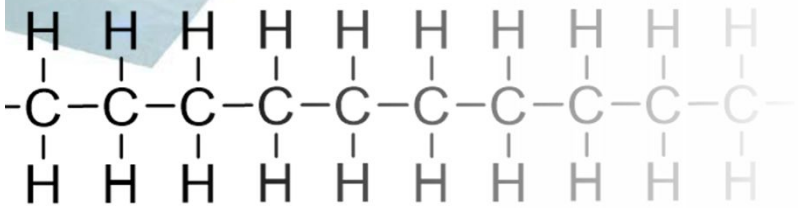


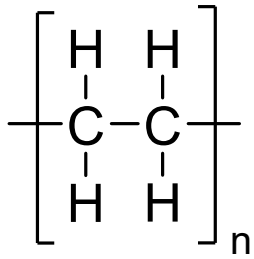
0.97 g/cm^3

(catene **lineari**)

più duro e resistente

plastiche

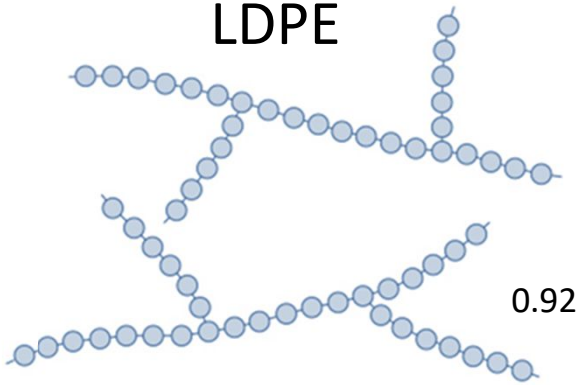




polietilene

più morbido
e flessibile

(Low Density)
LDPE

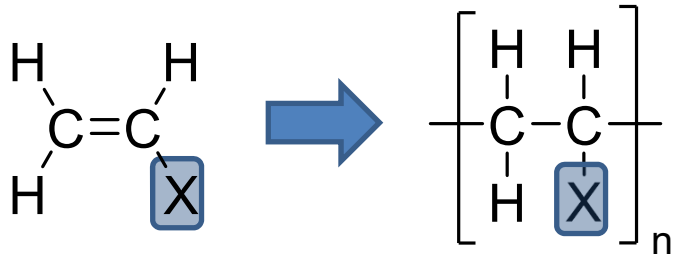


0.92 g/cm^3

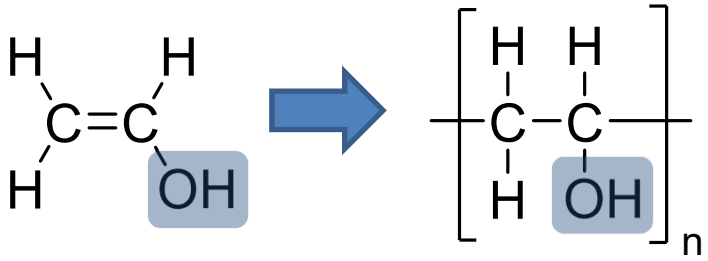
(catene **ramificate**)

plastiche

*derivati dell'*etilene

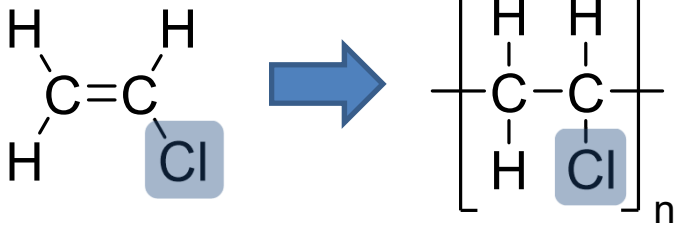


alcol vinilico



alcol polivinilico

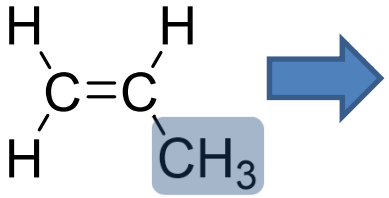
clururo di vinile

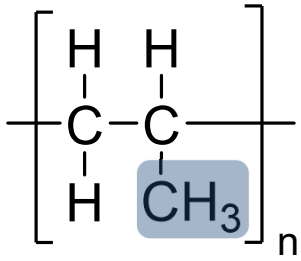


polivinilcloruro (PVC)

plastiche

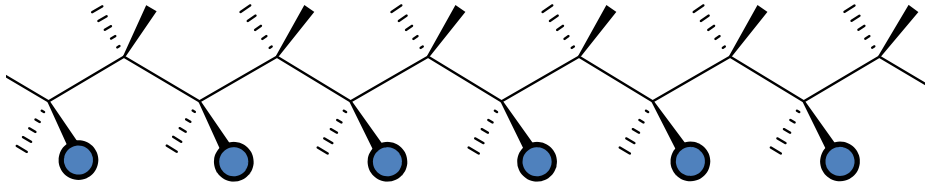
propilene



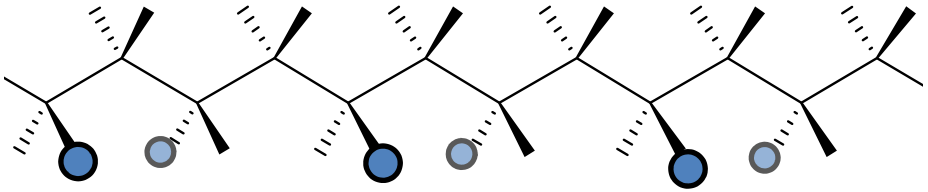


polipropilene (PP)

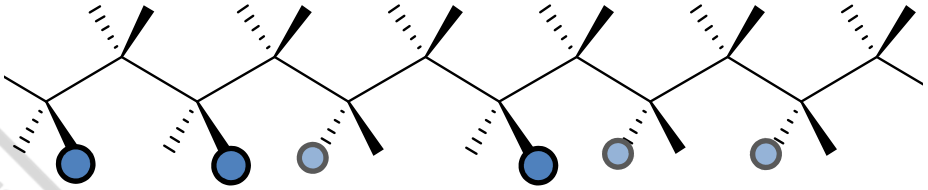
T_{fus} più alta migliori proprietà meccaniche



isotattico



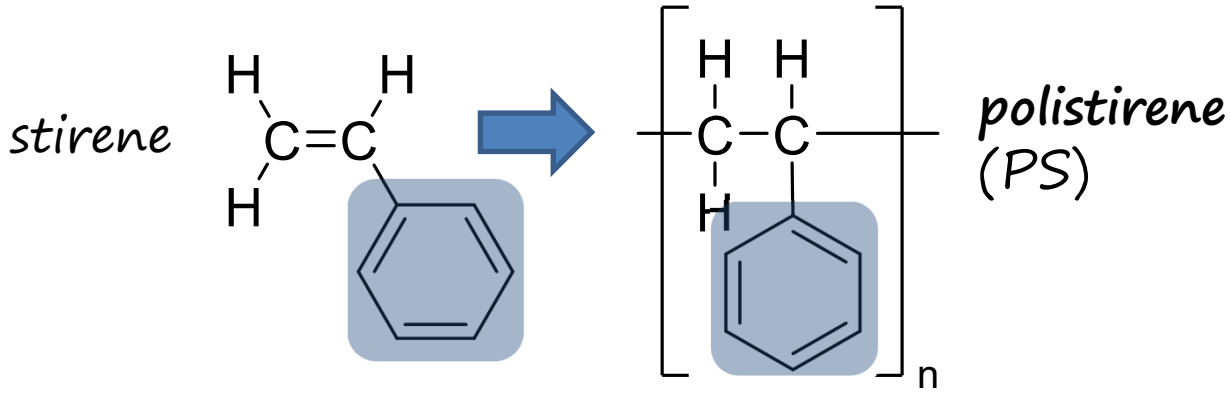
sindiotattico



atattico

polimeri **STEREOREGOLARI**

plastiche



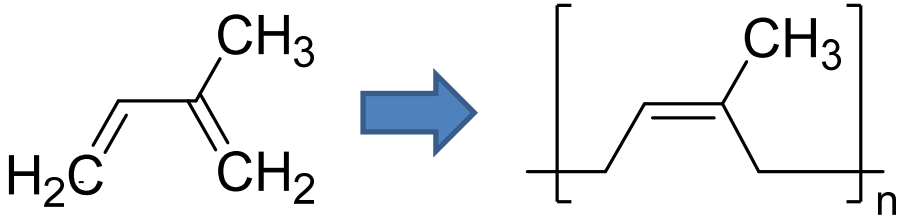
(polistirolo espanso)

elastomeri

(o gomme)

si deformano quando sottoposti a carico per poi riassumere forma originale

caucciù
(gomma naturale)



isoprene — cis-poliisoprene

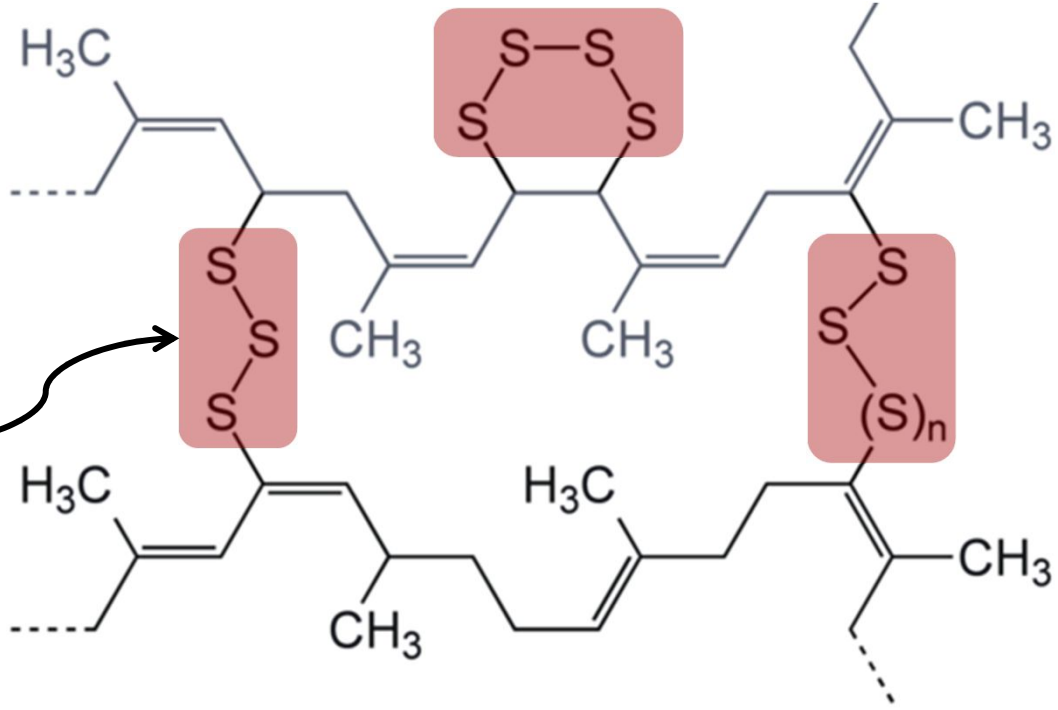
utilizzo limitato:
poco resistente,
morbida e appiccicosa,
dura e fragile a basse T

elastomeri

Charles Goodyear

vulcanizzazione (1839)

formazione ponti solfuro



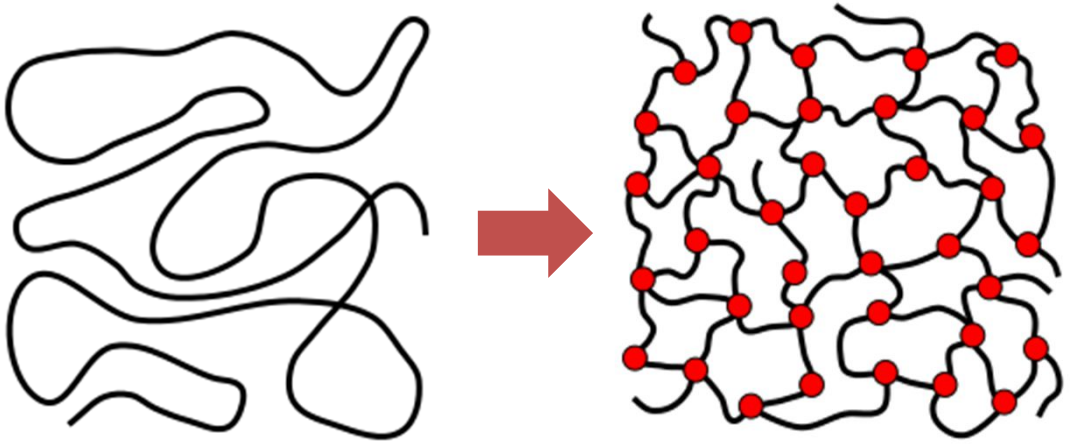
elastomeri

Charles Goodyear

vulcanizzazione
(1839)

più duro e resistente!

formazione ponti solfuro



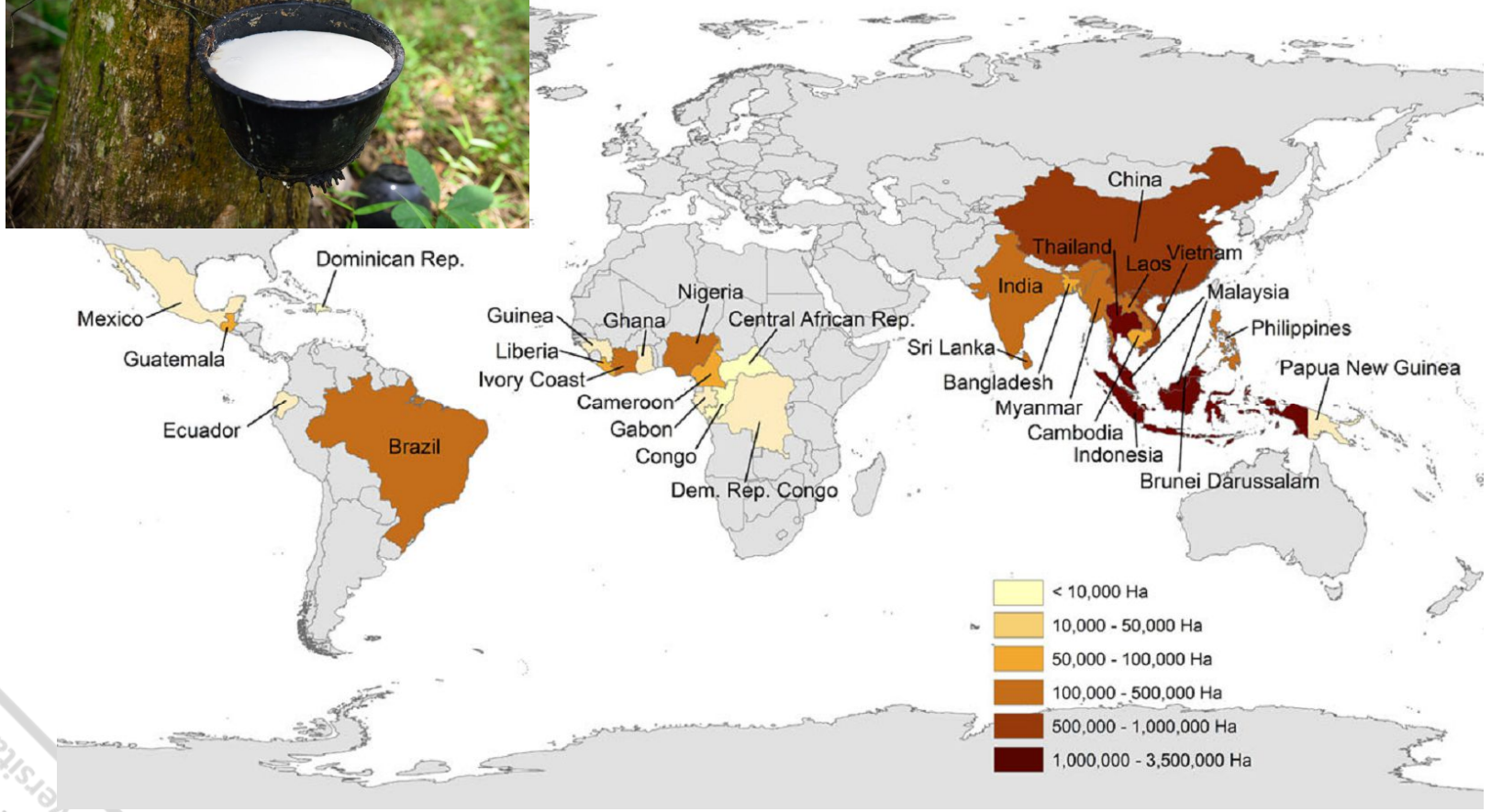
catene lineari

catene reticolate
(● = *ponti solfuro*)

elastomeri

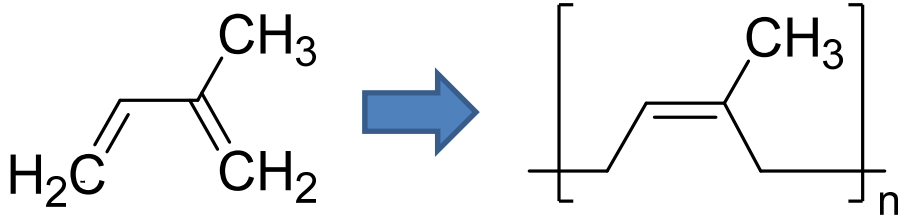
Brasile → sudest asiatico

estensione piantagioni caucciù

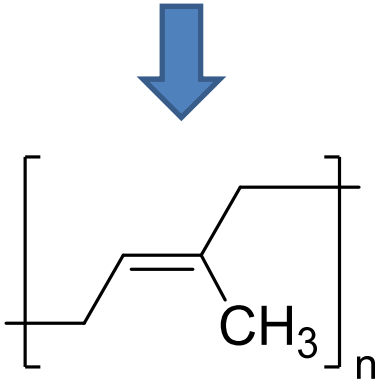


elastomeri

*oggi **cis-poliisoprene** prodotto sintenticamente*
(produzione annua in milioni di tonnellate)



isoprene *cis-poliisoprene*



trans-poliisoprene

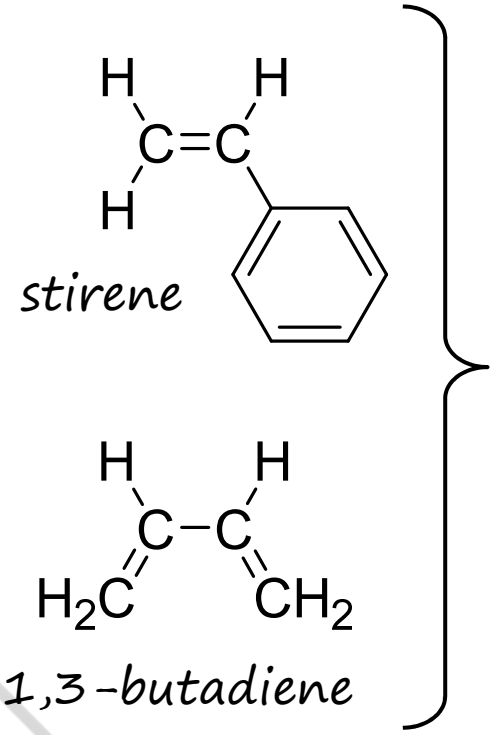
guttaperca
(origine naturale)

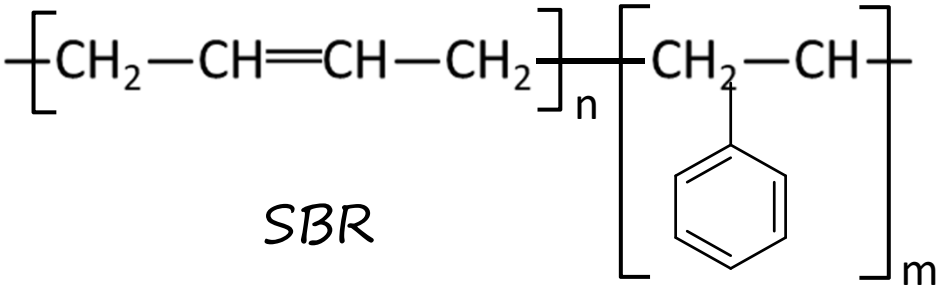
elastomeri

formati da 2 o più monomeri

co-polimeri

gomma stirene butadiene (SBR)

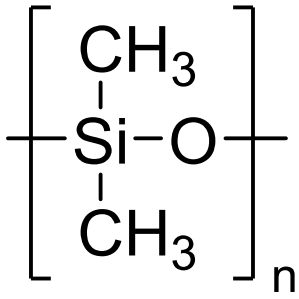




SBR

più importante gomma sintetica oggi

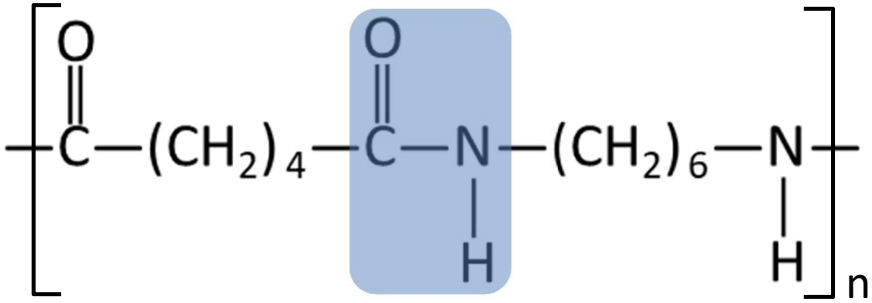
elastomeri



polisilossani
(siliconi, gomme siliconiche)

fibre polimeriche

poliammide

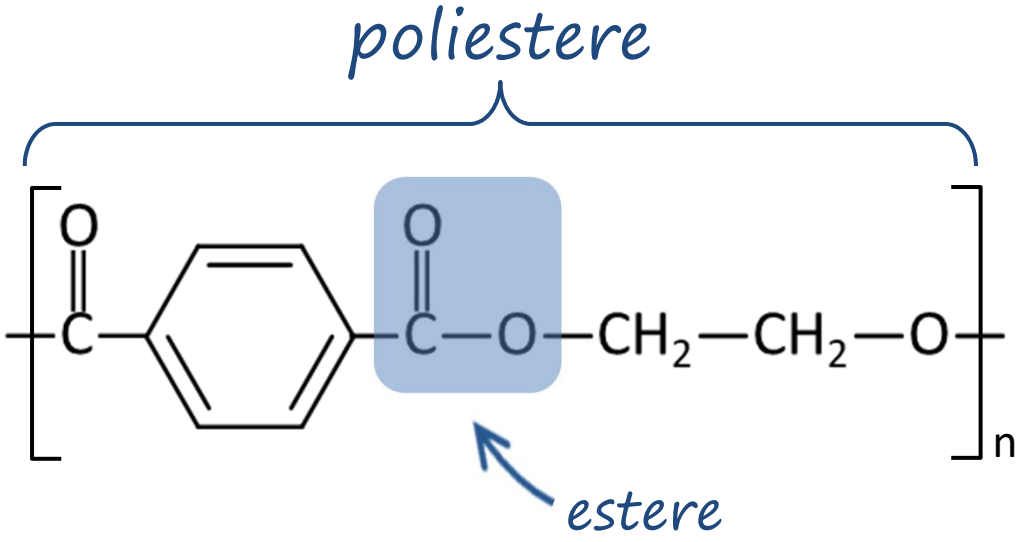


nylon 6,6

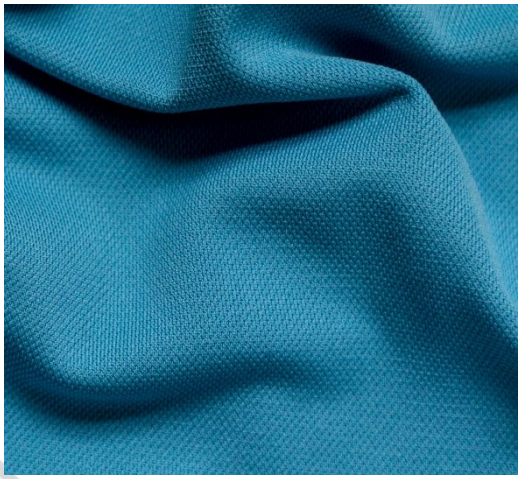
ammide

le poliammidi sono fibre particolarmente resistenti

fibre polimeriche



politereftalato
di etilene (PET)

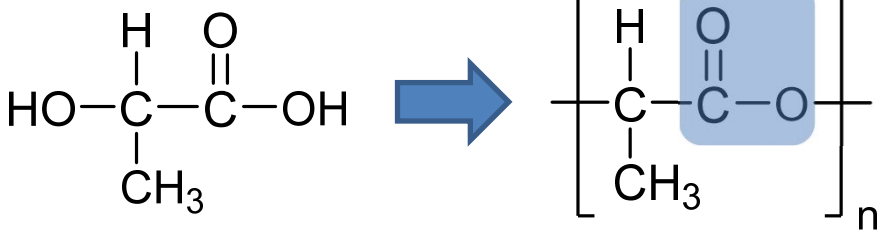


PET ottimo sia come fibra che come materia plastica

acido polilattico

(un poliestere interessante)

estere



acido lattico (monomero)

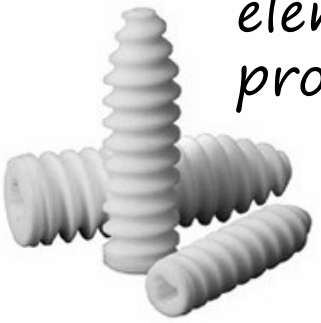
da fermentazione lattica

acido polilattico (PLA)

(BIODEGRADABILE!)

'BIOPLASTICA'

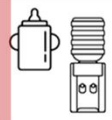
alimentare



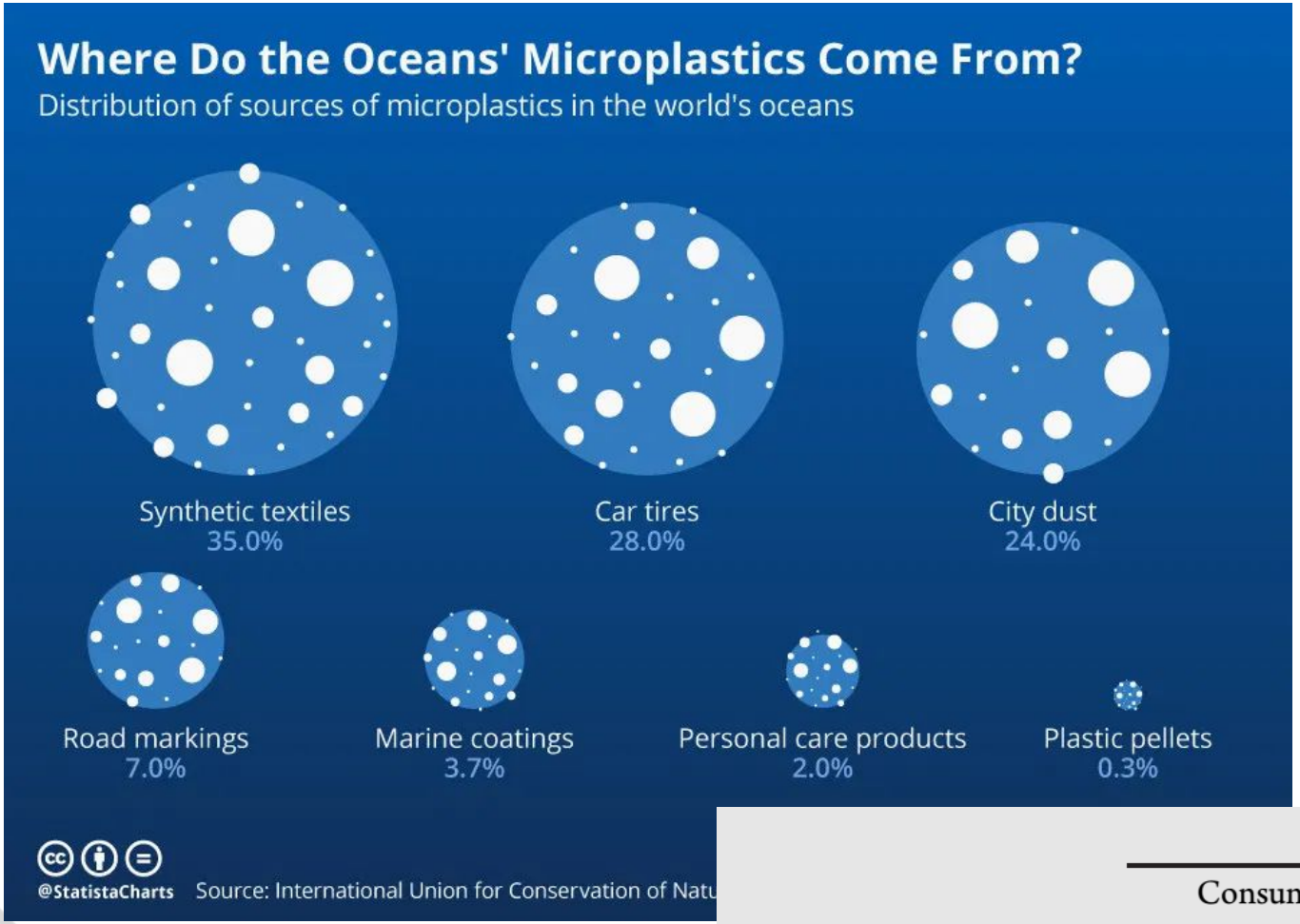
elementi protesici

stampa 3D

polimeri e *riciclo*

Symbol	Polymer	Common Uses	Properties	Recyclable?
1 PETE	Polyethylene terephthalate	 Plastic bottles (water, soft drinks, cooking oil)	Clear, strong and lightweight	Yes; widely recycled
2 HDPE	High-density polyethylene	 Milk containers, cleaning agents, shampoo bottles, bleach bottles	Stiff and hardwearing; hard to breakdown in sunlight	Yes; widely recycled
3 PVC	Polyvinyl chloride	 Plastic piping, vinyl flooring, cabling insulation, roof sheeting	Can be rigid or soft via plasticizers; used in construction, healthcare, electronics	Often not recyclable due to chemical properties; check local recycling
4 LDPE	Low-density polyethylene	 Plastic bags, food wrapping (e.g. bread, fruit, vegetables)	Lightweight, low-cost, versatile; fails under mechanical and thermal stress	No; failure under stress makes it hard to recycle
5 PP	Polypropylene	 Bottle lids, food tubs, furniture, houseware, medical, rope, automobile parts	Tough and resistant; effective barrier against water and chemicals	Often not recyclable; available in some locations; check local recycling
6 PS	Polystyrene	 Food takeway containers, plastic cutlery, egg tray	Lightweight; structurally weak; easily dispersed	No; rarely recycled but check local recycling
7 OTHER	Other plastics (e.g. acrylic, polycarbonate, polyactic fibres)	 Water cooler bottles, baby cups, fiberglass	Diverse in nature with various properties	No; diversity of materials risks contamination of recycling

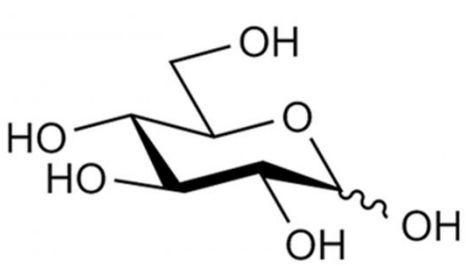
il problema delle microplastiche



	Daily	
	Consumed	Inhaled
Male Children	113	110
Male Adults	142	170
Female Children	106	97
Female Adults	126	132

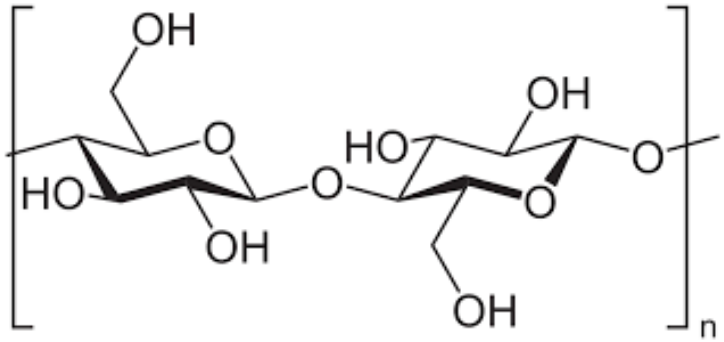
Environ. Sci. Technol. 2019, 53, 7068–7074

biopolimeri



glucosio
(monomero)

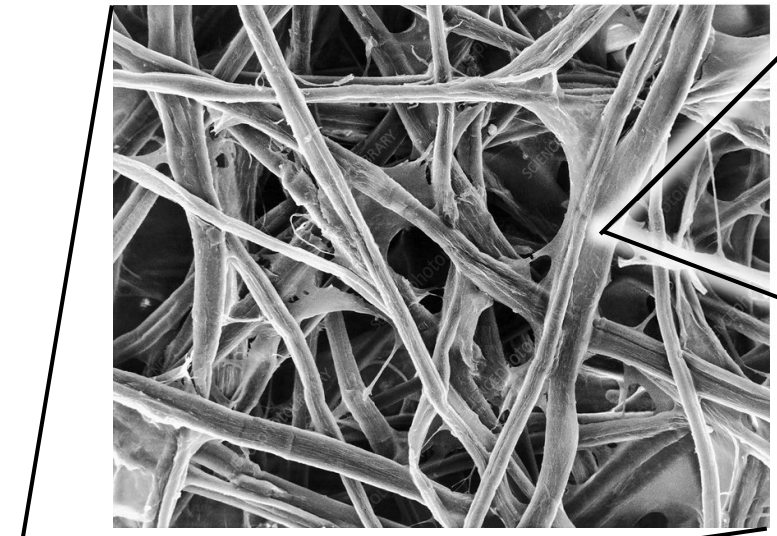
(carboidrato)

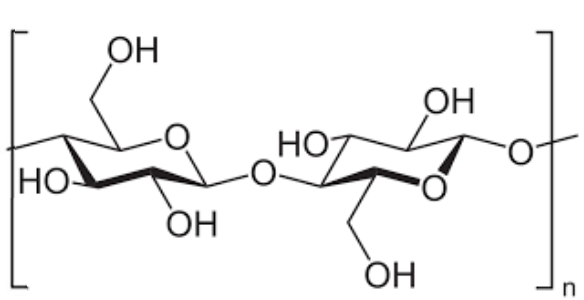


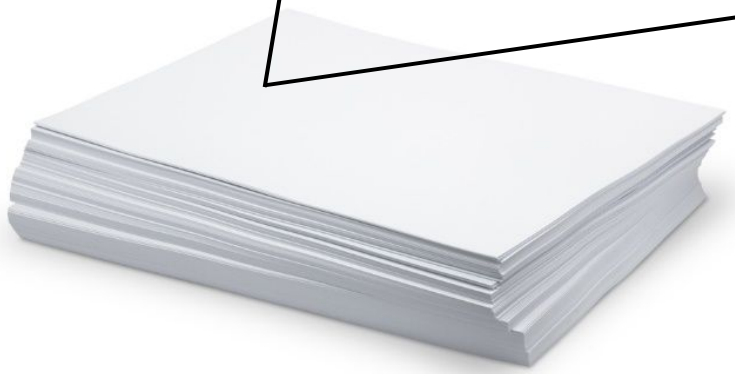
cellulosa

(polisaccaride)

biopolimeri

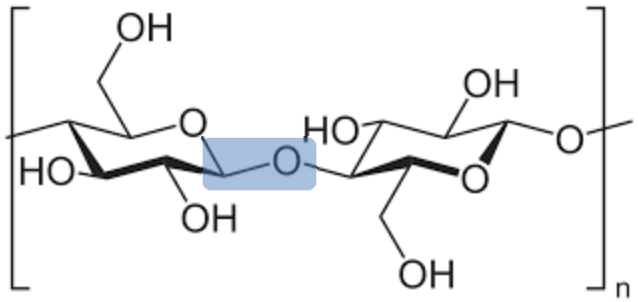




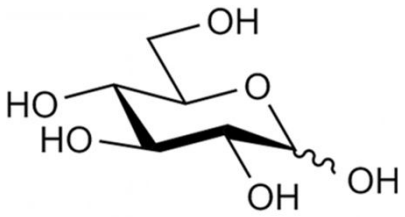


struttura a fibre

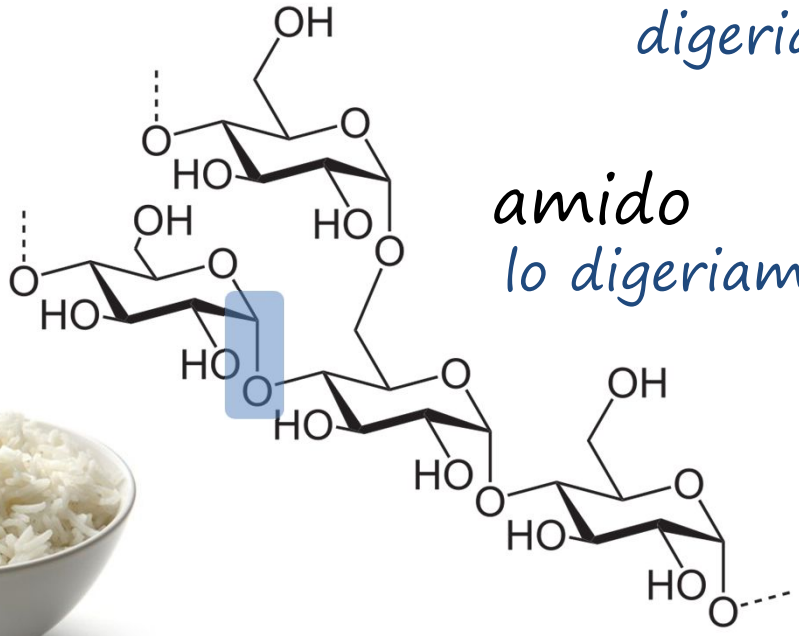
biopolimeri



cellulosa *non la digeriamo*



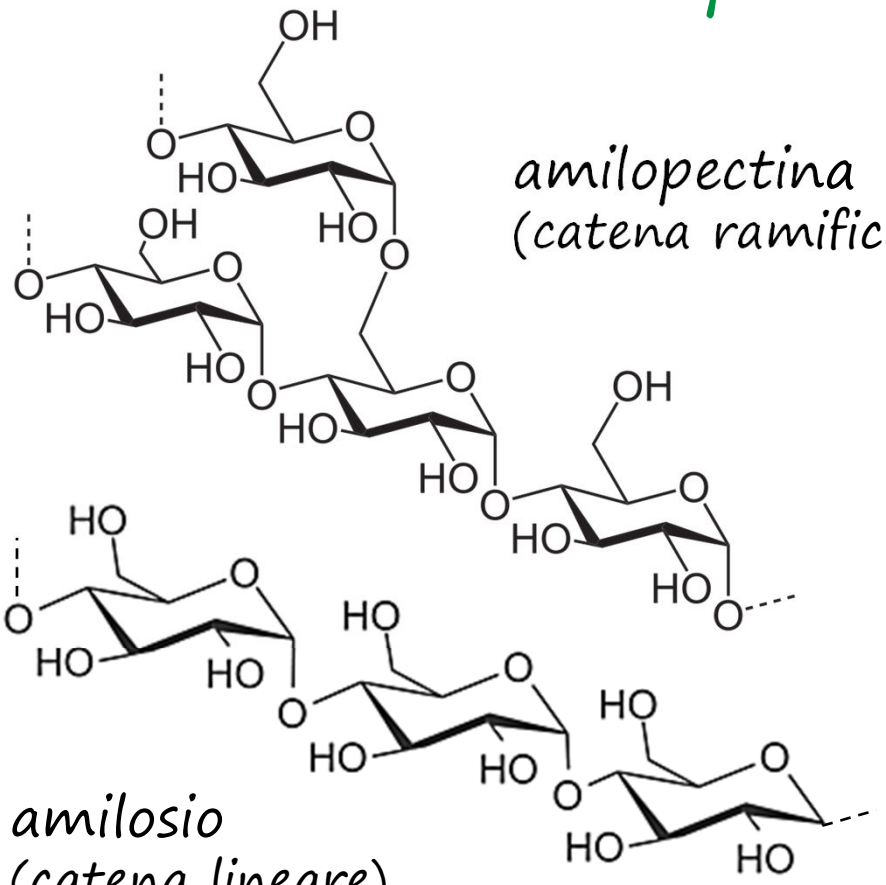
glucosio (monomero)



amido
lo digeriamo!

biopolimeri

bioplastiche

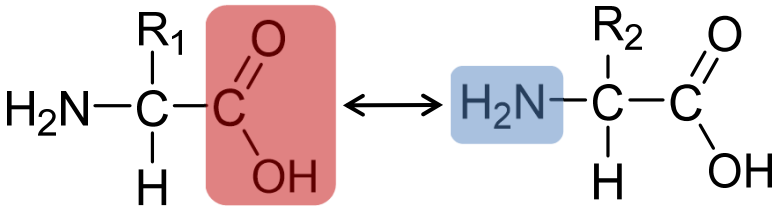


amilopectina
(catena ramificata)

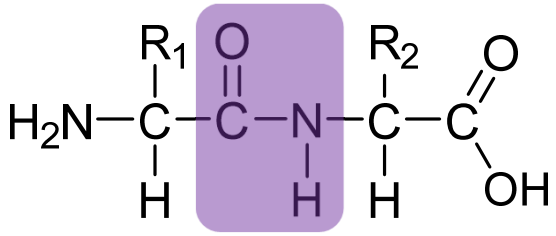
amilosio
(catena lineare)

biopolimeri

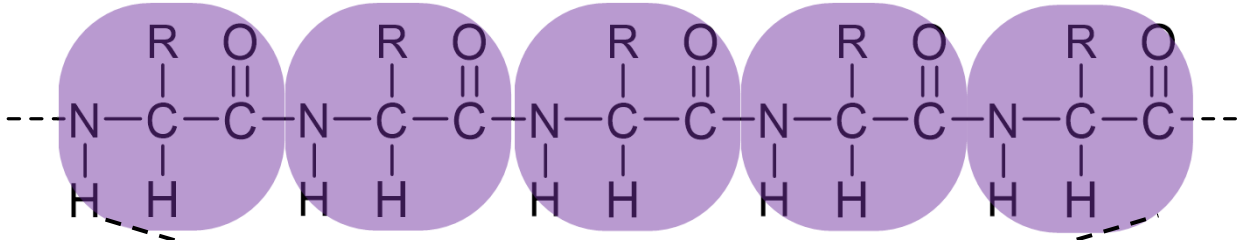
ce ne sono 21 diversi



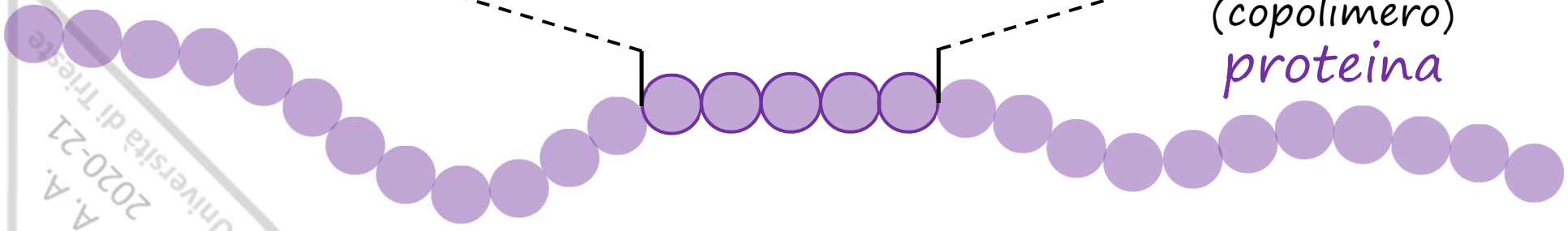
amino acidi (monomeri)



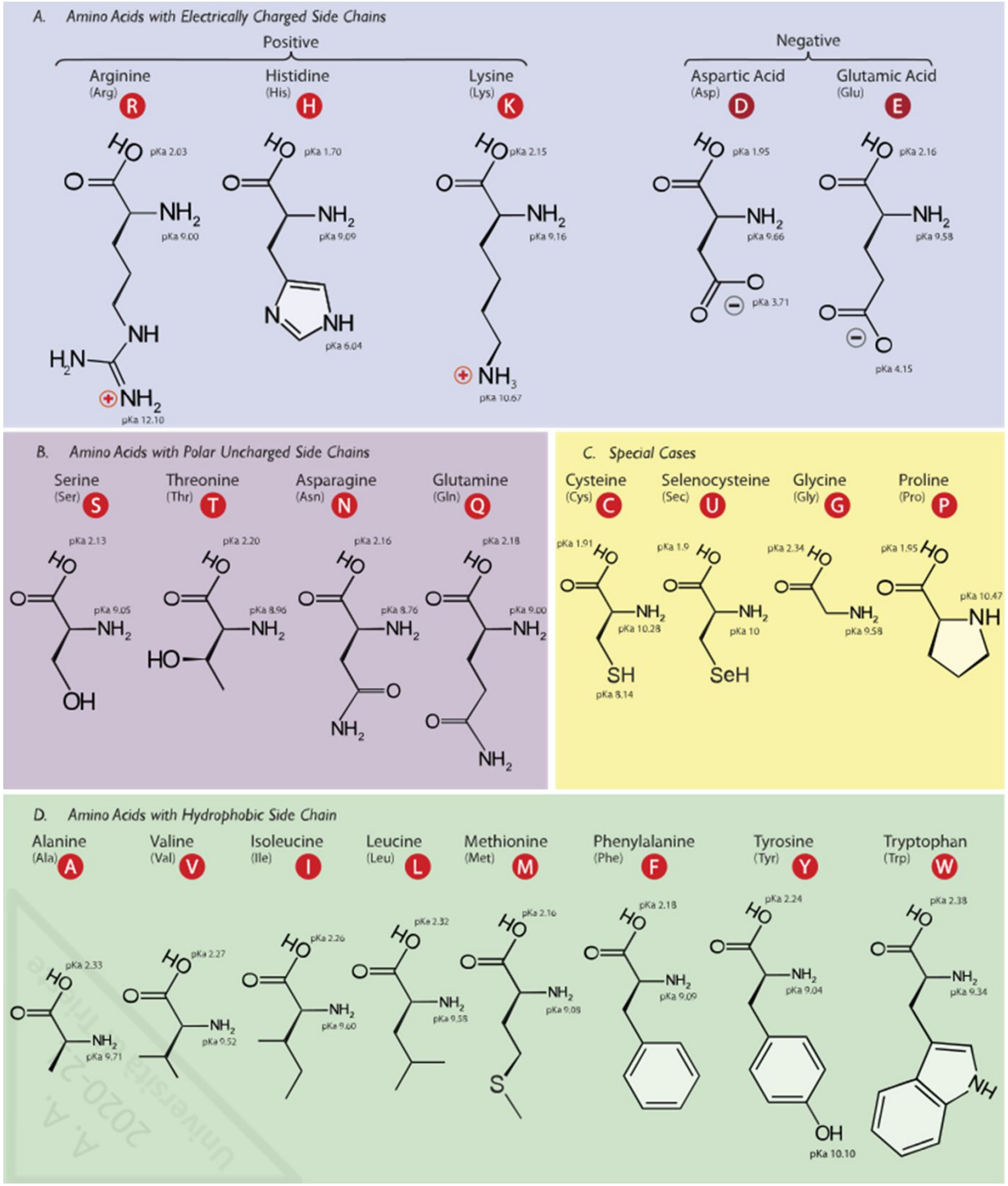
legame peptidico (ammidico)



(copolimero) proteina

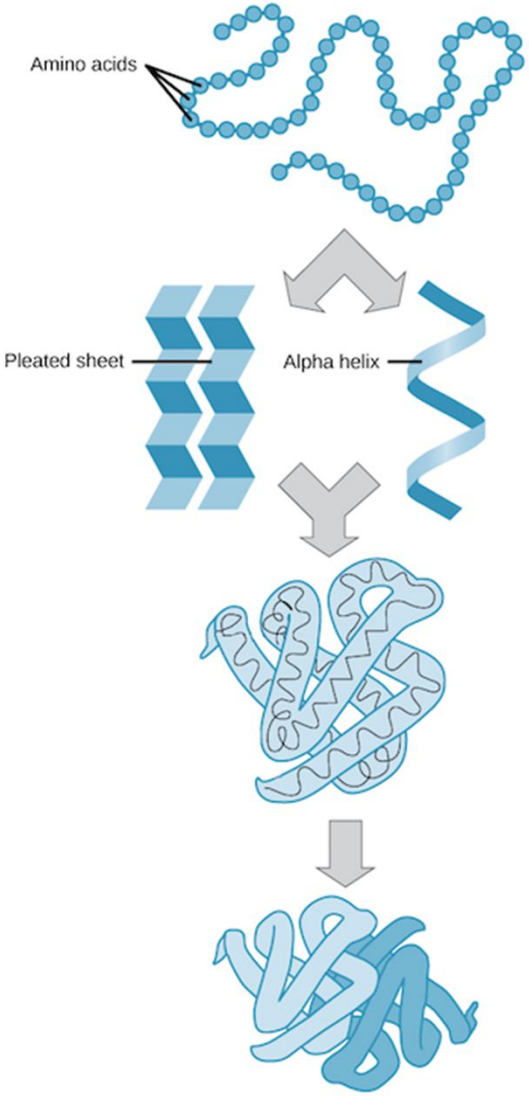


biopolimeri



21
amino
acidi
principali

biopolimeri



sequenza di amino acidi

ripiegamento

struttura secondaria

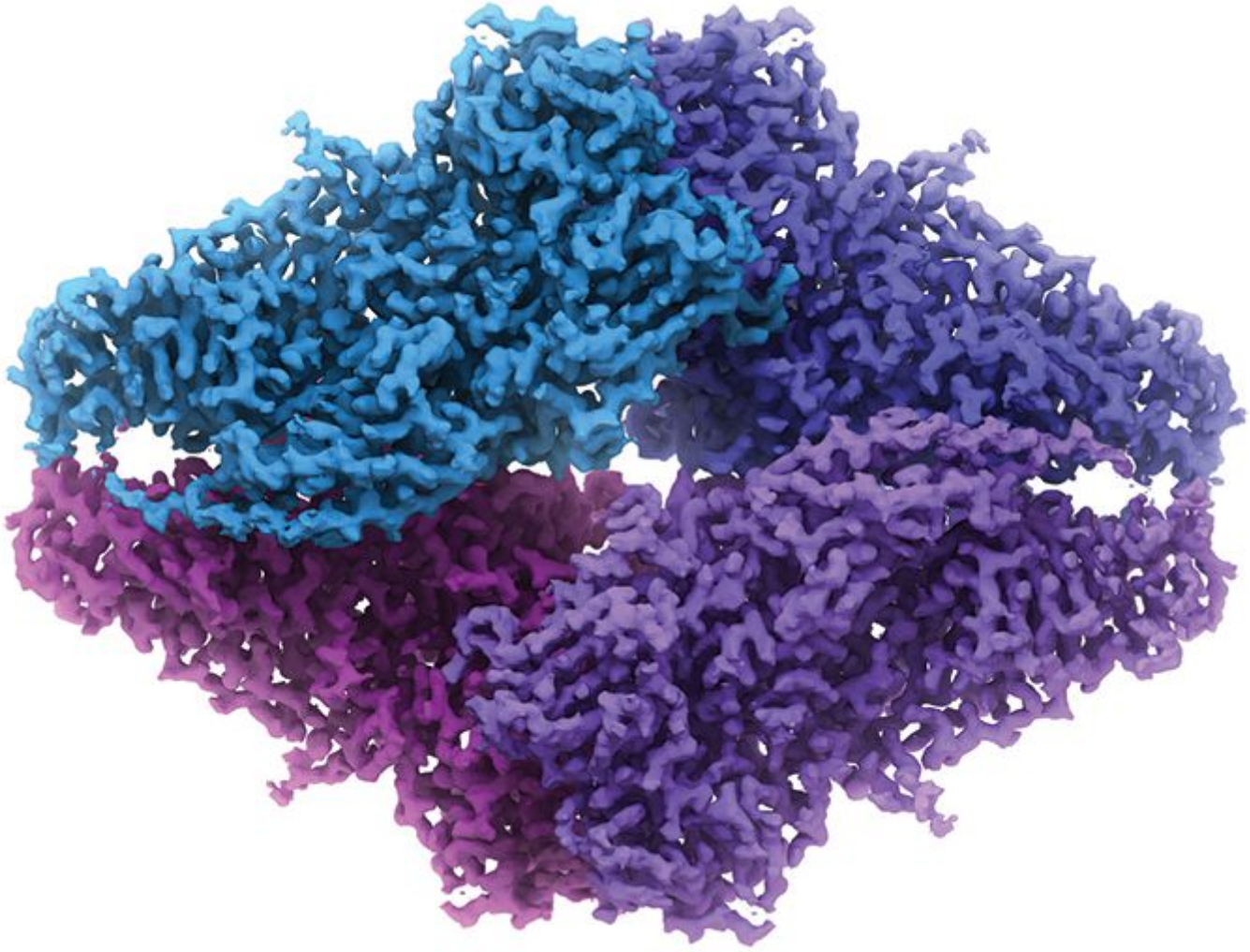
ripiegamento

struttura terziaria

ripiegamento

struttura quaternaria

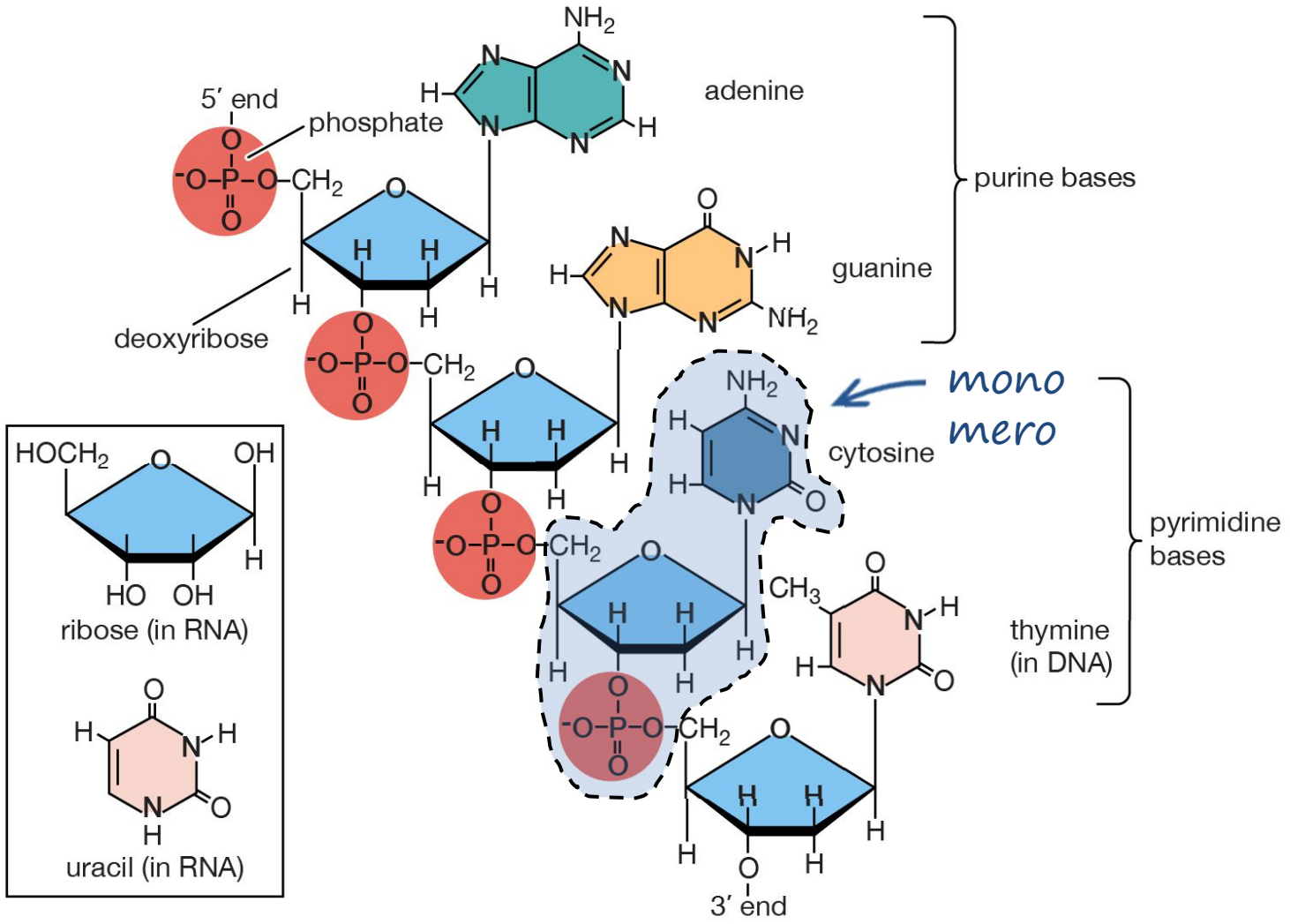
biopolimeri



(beta-galattossidasi – immagine da microscopia crioelettronica)

biopolimeri

acidi nucleici (DNA, RNA) (copolimeri)



biopolimeri