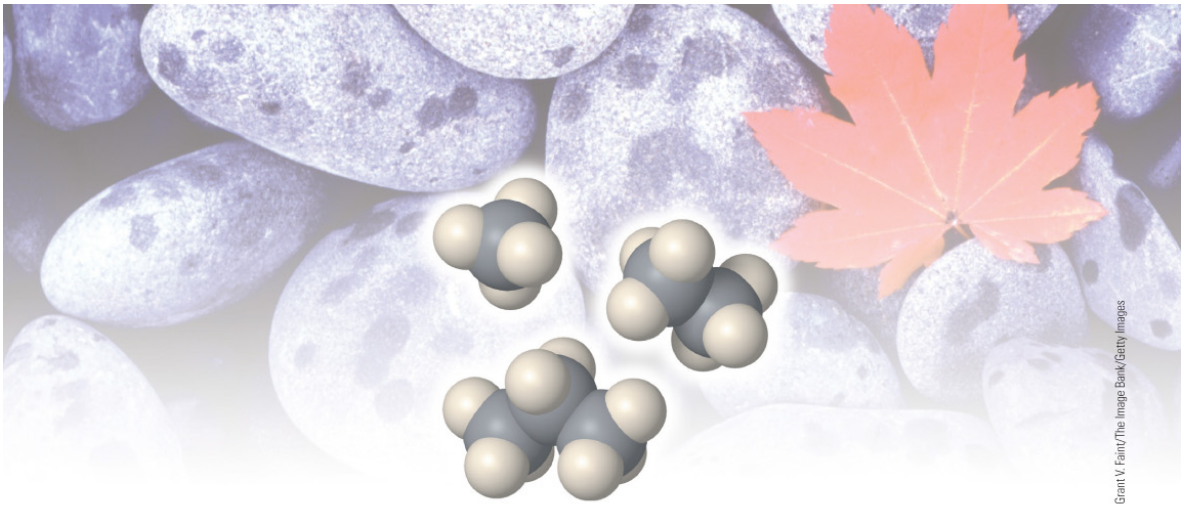
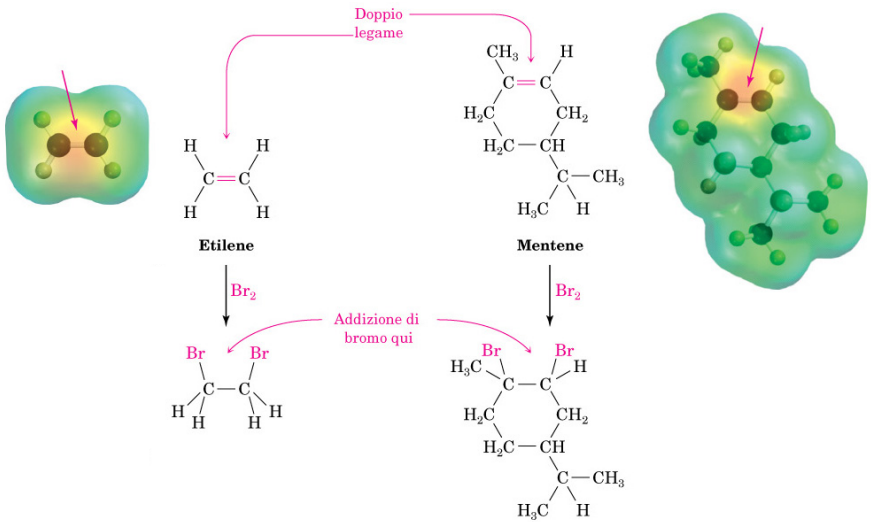
Gruppi funzionali



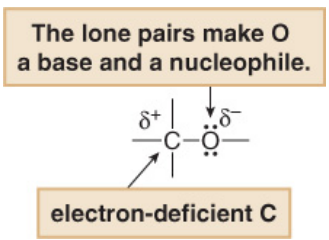
La reattività chimica di ogni molecola organica, indipendentemente dalle sue dimensioni o dalla sua complessità, è determinata dai gruppi funzionali che essa contiene

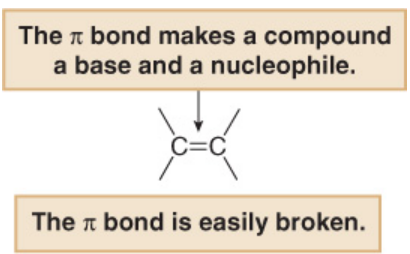


Reazione di etilene e mentene con il bromo. In entrambe le molecole, le mappe di potenziale elettrostatico mostrano che il gruppo funzionale con doppio legame C=C ha caratteristiche di polarità simili. Il bromo reagisce con le due molecole esattamente allo stesso modo, e non sono rilevanti la dimensione e la complessità della restante parte della molecola.

- **Un gruppo funzionale è un atomo o un gruppo di atomi con proprietà chimiche e fisiche tipiche. E' la parte reattiva della molecola.**
- **La maggior parte delle molecole organiche hanno legami C—C e C—H. Comunque, molte molecole organiche hanno anche altre caratteristiche strutturali:**
  - **Eteroatomi— Atomi diversi dal carbonio o idrogeno.**
  - **Legami π — I legami π più comuni sono presenti nei doppi legami C—C e C—O.**
  - **Queste caratteristiche strutturali distinguono una molecola organica da un'altra. Determinano inoltre la geometria della molecola, le sue proprietà fisiche, la reattività e includono quello che è chiamato gruppo funzionale.**

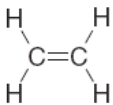
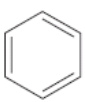
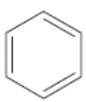
- **Gli eteroatomi e i legami π conferiscono reattività ad una particolare molecola.**
  - **Gli eteroatomi hanno coppie solitarie e creano sul carbonio siti carenti di elettroni.**
  - **I legami π si rompono facilmente nelle reazioni chimiche. Un legame π fa della molecola una base e un nucleofilo.**



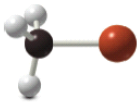
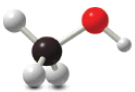
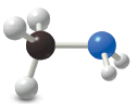
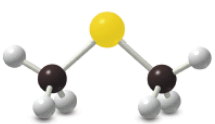


Non bisogna pensare che i legami C—C e C—H siano privi di importanza. Essi formano la spina dorsale carboniosa o lo scheletro al quale sono legati i gruppi funzionali.

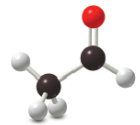
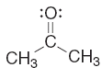
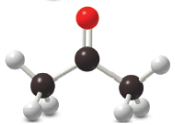
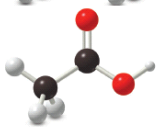
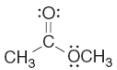
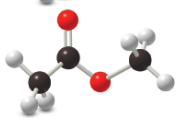
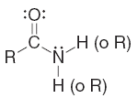
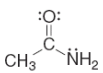
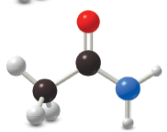
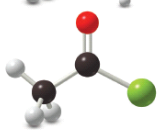
IDROCARBURI

Tipo di composto	Struttura generale	Esempio	Gruppo funzionale
Alcano	R—H	CH_3CH_3	– –
Alchene			legame doppio
Alchino	—C≡C—	H—C≡C—H	legame triplo
Composto aromatico			gruppo fenile

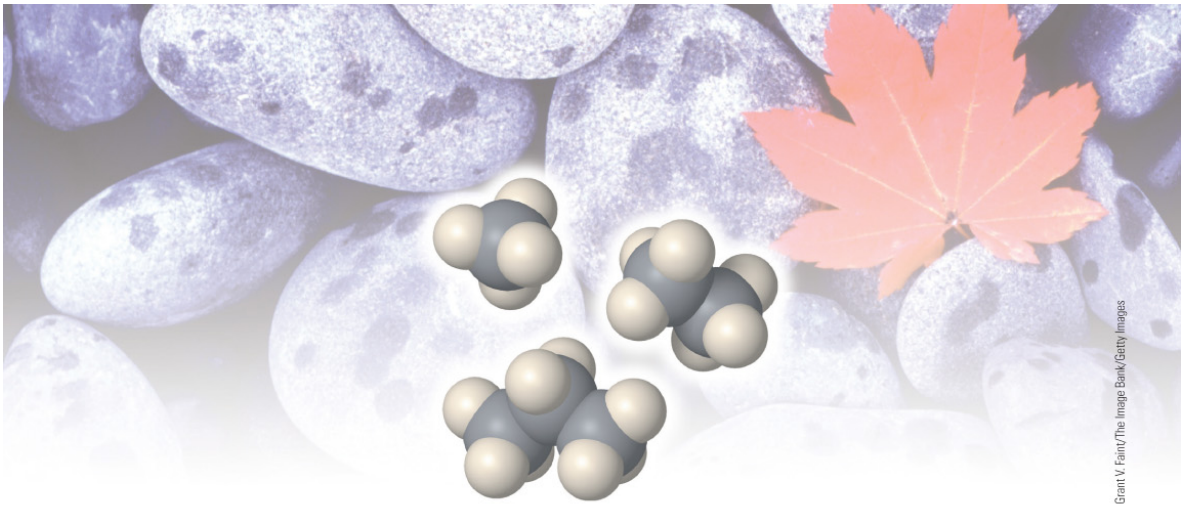
COMPOSTI CONTENENTI LEGAMI σ C-Z

Tipo di composto	Struttura generale	Esempio	Struttura 3–D	Gruppo funzionale
Alogenuro alchilico	R—$\ddot{\underset{..}{X}}$: (X=F, Cl, Br, I)	CH_3—$\ddot{\underset{..}{Br}}$:		**–X** gruppo alogeno
Alcol	R—$\ddot{\underset{..}{O}}$H	CH_3—$\ddot{\underset{..}{O}}$H		**–OH** gruppo idrossi
Etere	R—$\ddot{\underset{..}{O}}$—R	CH_3—$\ddot{\underset{..}{O}}$—CH_3		**–OR** gruppo alcossi
Ammina	R—$\ddot{N}H_2$ o $R_2\ddot{N}H$ o $R_3\ddot{N}$	CH_3—$\ddot{N}H_2$		**–NH_2** gruppo ammino
Tiolo	R—$\ddot{\underset{..}{S}}$H	CH_3—$\ddot{\underset{..}{S}}$H		**–SH** gruppo mercapto
Solfuro	R—$\ddot{\underset{..}{S}}$—R	CH_3—$\ddot{\underset{..}{S}}$—CH_3		**–SR** gruppo alchiltio

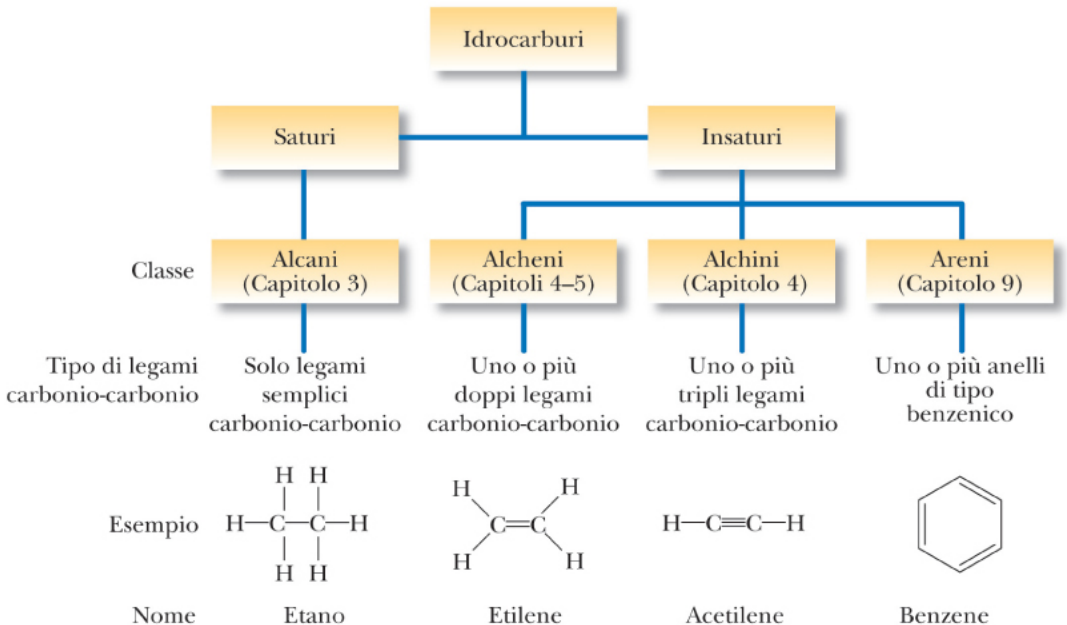
COMPOSTI CONTENENTI UN GRUPPO C=O

Tipo di composto	Struttura generale	Esempio	Struttura3–D	Gruppo funzionale
Aldeide				C=O gruppo carbonilico
Chetone				C=O gruppo carbonilico
Acido carbossilico				—COOH gruppo carbossilico
Estere				—COOR
Ammide				—$CONH_2$, —CONHR, —$CONR_2$
Cloruro acilico				—COCl

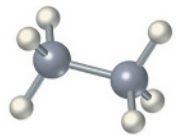
Alcani

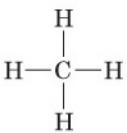


Idrocarburi: composti contenenti soltanto carbonio e idrogeno

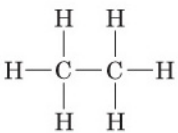


C_nH_{2n+2}

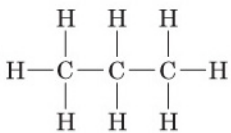




Metano, CH_4



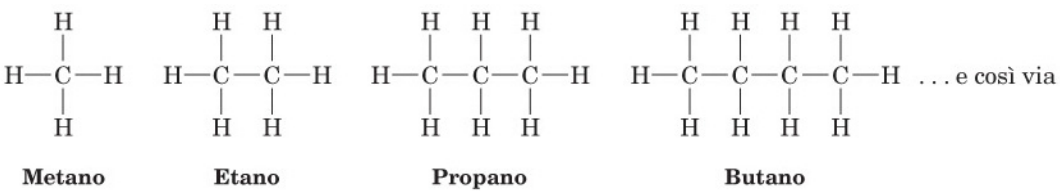
Etano, C_2H_6



Propano, C_3H_8

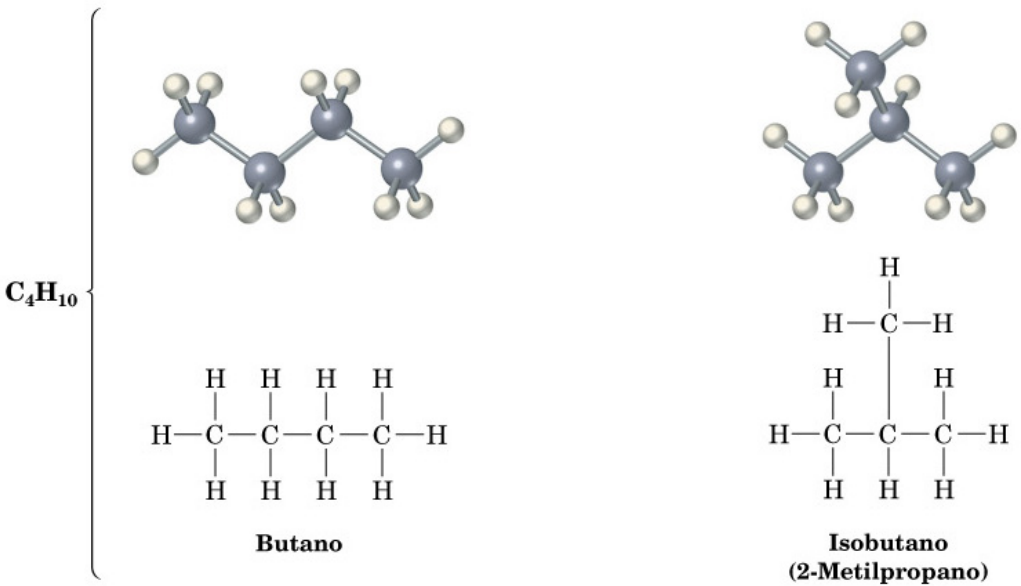
Idrocarburi saturi

perchè hanno il massimo numero di atomi di idrogeno per atomo di carbonio

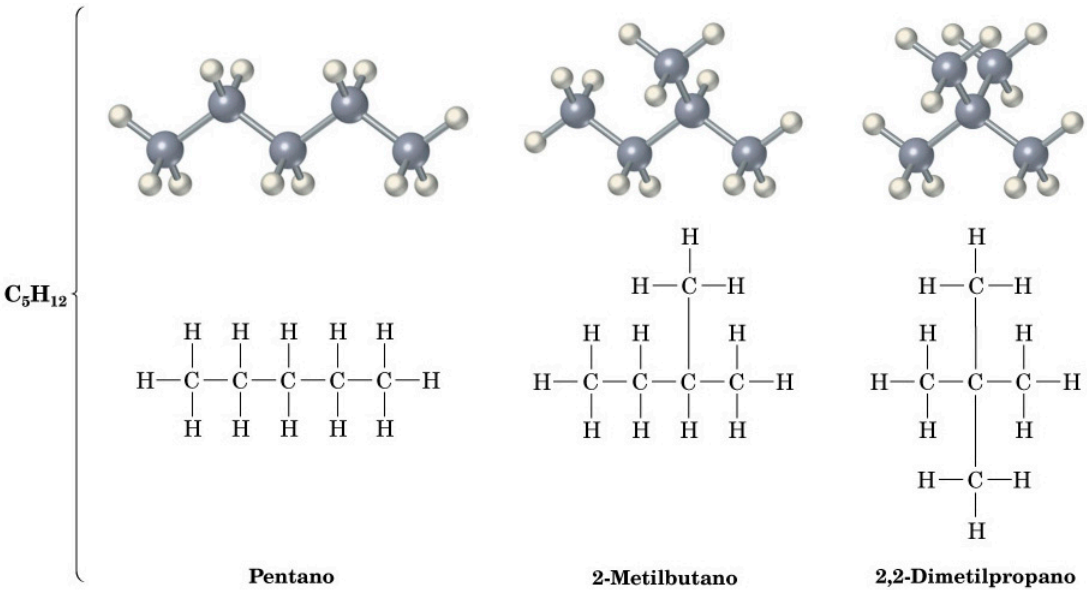


Alcani a catena lineare o normale e a catena ramificata Ci sono due modi diversi di disporre quattro atomi di carbonio, da cui risultano due composti con formula molecolare C_4H_{10}, che sono il butano e l'isobutano.

•Il butano e l'isobutano sono isomeri



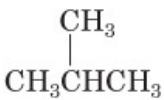
Isomeria costituzionale. Gli isomeri sono composti che hanno la stessa formula molecolare ma differente formula di struttura (differente connettività o tipo di legami).



Isomeri costituzionali

Proprietà chimiche diverse

Scheletro carbonioso diverso
C_4H_{10}



2-Metilpropano (Isobutano)

e

$CH_3CH_2CH_2CH_3$

Butano

Gruppi funzionali diversi
C_2H_6O

CH_3CH_2OH

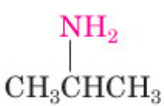
Alcol etilico

e

CH_3OCH_3

Dimetil etere

Posizione diversa dei gruppi funzionali
C_3H_9N



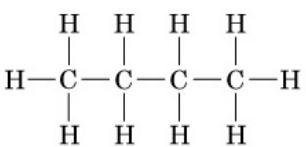
Isopropilammina

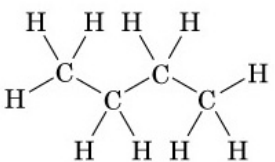
e

$CH_3CH_2CH_2NH_2$

Propilammina

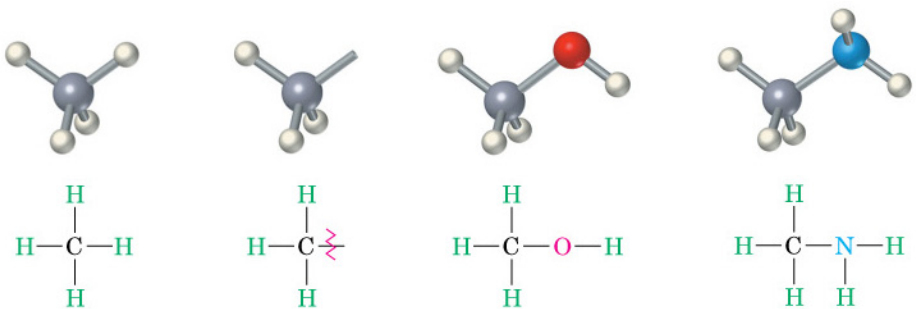
Ecco come può essere rappresentata la formula del butano, C_4H_{10}. La molecola è sempre la stessa, anche se la struttura è disegnata in modi diversi: essa deve solo contenere una catena lineare di quattro atomi di carbonio, senza che sia necessario rispettare una forma geometrica specifica.





$CH_3—CH_2—CH_2—CH_3$ $\quad$ $CH_3CH_2CH_2CH_3$ $\quad$ $CH_3(CH_2)_2CH_3$

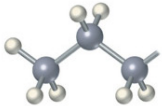
Gruppi alchilici: **strutture che rimangono dopo aver eliminato un atomo di idrogeno da un alcano**



C_3

$CH_3CH_2CH_3$

Propano



$CH_3CH_2CH_2$–

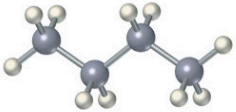
Propile

e

$CH_3CH(\wedge)CH_3$

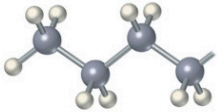
Isopropile

C_4



$CH_3CH_2CH_2CH_3$

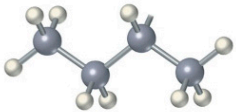
Butano



$CH_3CH_2CH_2CH_2$–

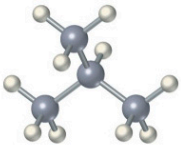
Butile

e



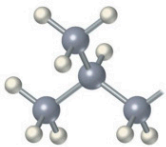
$CH_3CH_2CH(\wedge)CH_3$

***sec*-Butile**



$CH_3CH(CH_3)CH_3$

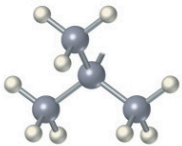
Isobutano



$CH_3CH(CH_3)CH_2$–

Isobutile

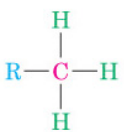
e



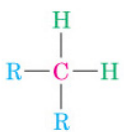
$CH_3-C(CH_3)_2$–

***tert*-Butile**

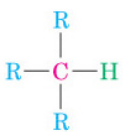
I prefissi sec- e ter- o tert- si riferiscono al numero di atomi di carbonio legati all'atomo di carbonio ramificato



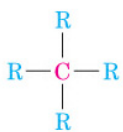
Il carbonio *primario* (1°) è legato ad un altro atomo di carbonio



Il carbonio *secondario* (2°) è legato ad altri due atomi di carbonio



Il carbonio *terziario* (3°) è legato ad altri tre atomi di carbonio



Il carbonio *quaternario* (4°) è legato ad altri quattro atomi di carbonio

Nomenclatura (IUPAC)

Prefisso—Radice—Desinenza

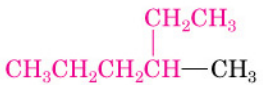
Dove si trovano i sostituenti?

Quanti sono gli atomi di carbonio?

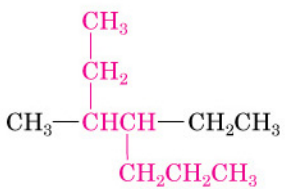
Di quale famiglia si tratta?

Identificare l'idrocarburo di origine

identificare la catena continua di atomi di carbonio più lunga

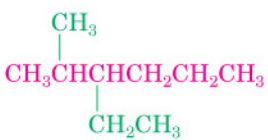


Denominato come un esano sostituito



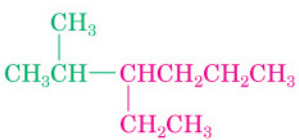
Denominato come un eptano sostituito

se vi sono due catene della medesima lunghezza, scegliere come principale quella con il maggior numero di punti di ramificazione



Denominato come un esano con *due* sostituenti

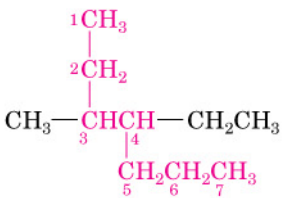
NON



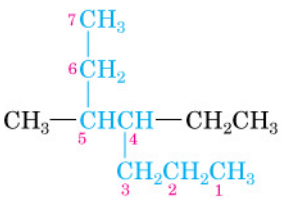
Come un esano con *un* sostituente

Attribuire un numero agli atomi della catena principale

numerare ciascun atomo di carbonio della catena principale cominciando dall' estremità più vicina al primo punto di ramificazione



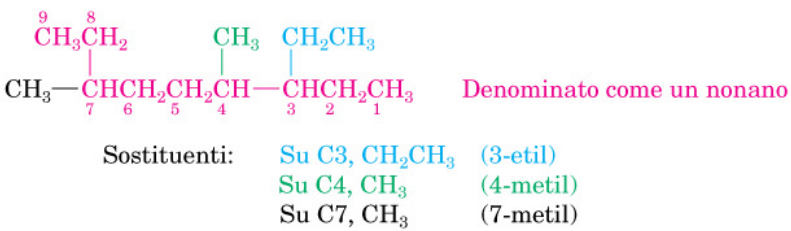
NON



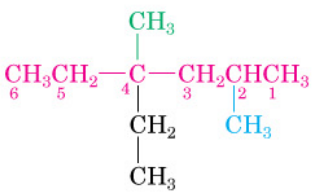
se la catena principale si ramifica alla stessa distanza dalle due estremità, la numerazione inizia dall' estremità più vicina al secondo punto di ramificazione

Identificare e attribuire un numero ai sostituenti

assegnare ad ogni sostituente il numero che corrisponde al suo punto di attacco alla catena principale



se vi sono due sostituenti legati allo stesso atomo di carbonio, si dia ad entrambi lo stesso numero

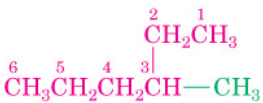


Denominato come un esano

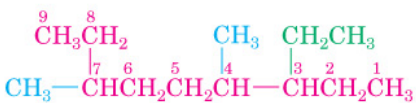
Sostituenti:	Su C2, CH_3	(2-metil)
	Su C4, CH_3	(4-metil)
	Su C4, CH_2CH_3	(4-etil)

Scrivere il nome come un' unica parola

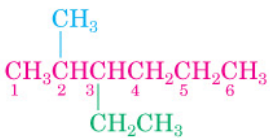
usare trattini per separare i diversi prefissi e virgole per separare i numeri
se vi sono più sostituenti diversi elencarli in ordine alfabetico
se ci sono due o più sostituenti uguali usare i prefissi di-, tri-, tetra-



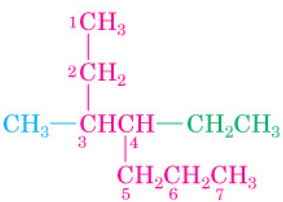
3-Metilesano



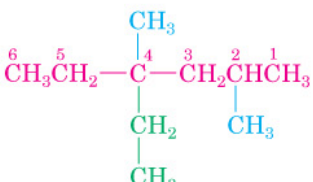
3-Etil-4,7-dimetilnonano



3-Etil-2-metilesano

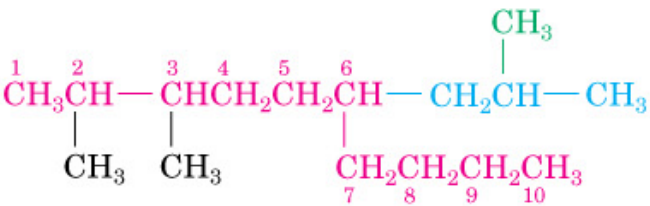


4-Etil-3-metileptano



4-Etil-2,4-dimetilesano

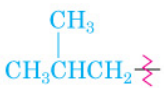
Dare un nome ad un sostituente complesso come se fosse un composto



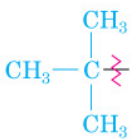
2,3-Dimetil-6-(2-metilpropil)decano

Isopropile (*i*-Pr)

***sec*-Butile (*sec*-Bu)**

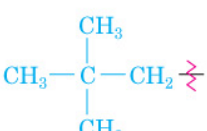


Isobutile

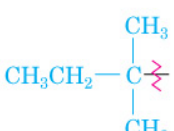


***tert*-Butile (*t*-Butile o *t*-Bu)**

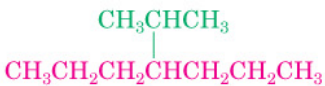
Isopentile detto anche isoamile (*i*-amile)



Neopentile



***tert*-Pentile, detto anche *tert*-amile (*t*-amile)**



4-(1-Metiletil)eptano o **4-Isopropileptano**

Reattività degli alcani

Si tratta di composti poco reattivi. Danno reazioni in condizioni drastiche.

$$CH_4 + Cl_2 \xrightarrow{h\nu} CH_3Cl + HCl$$

$$\xrightarrow{Cl_2} CH_2Cl_2 + HCl$$

$$\xrightarrow{Cl_2} CHCl_3 + HCl$$

$$\xrightarrow{Cl_2} CCl_4 + HCl$$

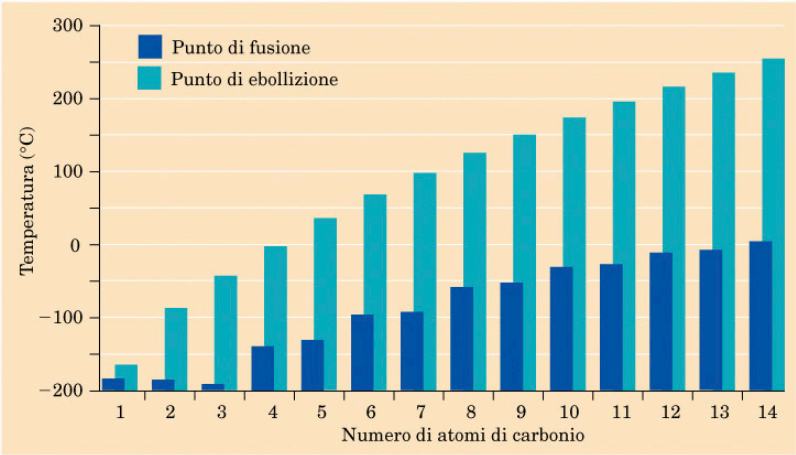
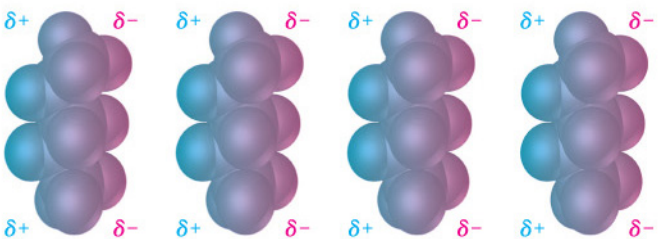
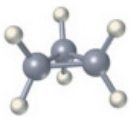


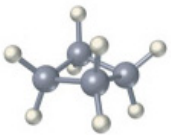
Diagramma del punto di fusione e del punto di ebollizione in funzione del numero di atomi di carbonio negli alcani da C1—C14. Si noti l'incremento regolare dei valori in relazione alla dimensione della molecola.

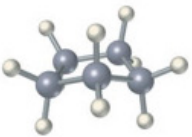
La causa delle forze dispersive di tipo attrattivo sono i dipoli temporanei nelle molecole, come si può vedere in questi modelli space-filling del pentano.

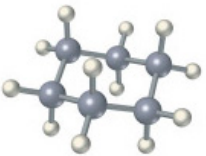


CICLOALCANI









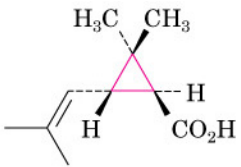
Ciclopropano

Ciclobutano

Ciclopentano

Cicloesano

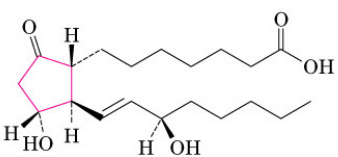
Cicloalcani in natura



Acido crisantemico

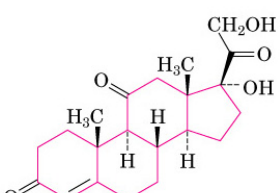
Insetticida naturale nel fiore di crisantemo

ormoni



Prostaglandina E_1 (PGE_1)

steroidi

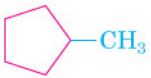


Cortisone

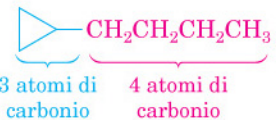
NOMENCLATURA

trovare la radice del nome:

cicloalcano alchil-sostituito oppure alcano cicloalchil-sostituito

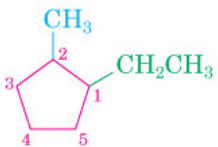


MA

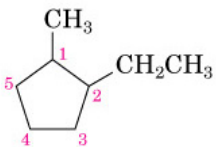


Metilciclopentano **1-Ciclopropilbutano**

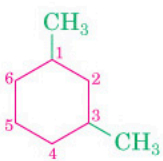
Attribuire un numero ai sostituenti e scrivere il nome



NON



1-Etil-2-metilciclopentano **2-Etil-1-metilciclopentano**



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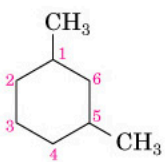
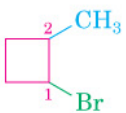


1,3-Dimetilcicloesano **1,5-Dimetilcicloesano**

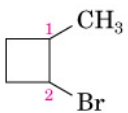
↑ più basso ↑ più alto

Ordine alfabetico dei sostituenti

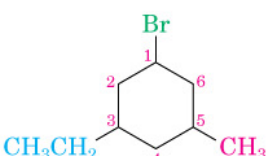


1-Bromo-2-metilciclobutano

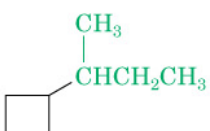
NON



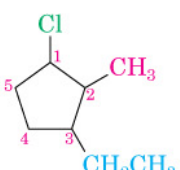
2-Bromo-1-metilciclobutano



1-Bromo-3-etil-5-metil-cicloesano

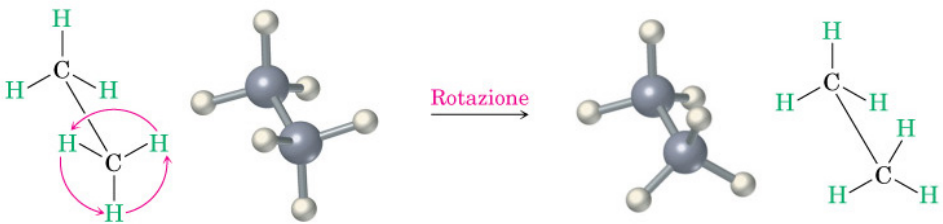


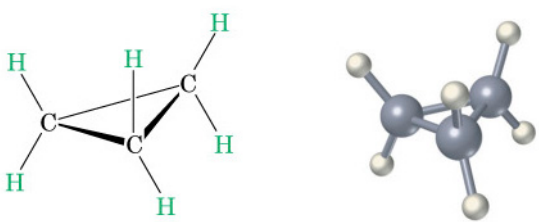
(1-Metilpropil)ciclobutano
(o *sec*-Butilciclobutano)



1-Cloro-3-etil-2-metil-ciclopentano

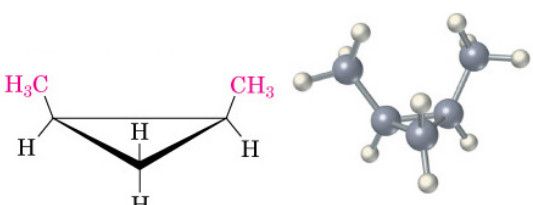
Ciclo-alcani: rotazione di legame



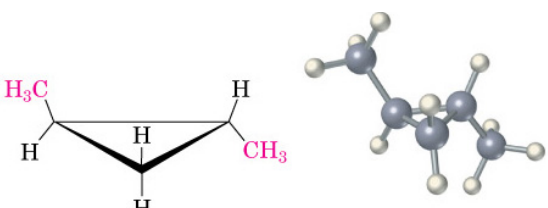


Struttura del ciclopropano. La rotazione intorno ai legami carbonio-carbonio non è possibile, a meno che non si rompa l'anello.

Esistono due diversi isomeri dell' 1,2-dimetilciclopropano, uno con i gruppi metilici dallo stesso lato dell' anello (cis), l' altro con i gruppi metilici sui due lati opposti (trans). I due isomeri non interconvertono.



***cis*-1,2-Dimetilciclopropano**

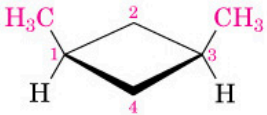


***trans*-1,2-Dimetilciclopropano**

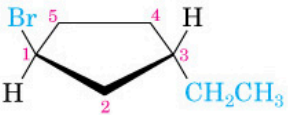
Ciclo-alcani: isomeria

Isomeri costituzionali (differenti connessioni tra gli atomi)

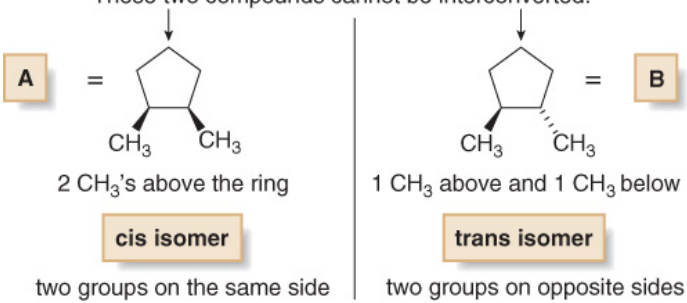
Stereoisomeri (stesse connessioni tra gli atomi ma differente orientamento tridimensionale)



***cis*-1,3-Dimetilciclobutano**



***trans*-1-Bromo-3-etilciclopentano**

A disubstituted cycloalkane: 1,2-dimethylcyclopentane

These two compounds cannot be interconverted.