

Spot the chiral carbon

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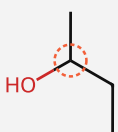
1 At a glance

Chiral carbon = an sp^3 carbon with four different groups

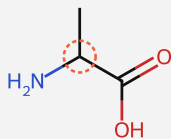
- A **chiral carbon** (stereocentre, C^*) is bonded to **four different groups**.
- Never a stereocentre: CH_3 and CH_2 carbons, and any carbon in $C=C$, $C=O$ or $C\equiv C$.
- Compare **whole groups**: follow each branch outwards until the groups differ.
- A molecule with n stereocentres has at most 2^n stereoisomers, fewer if a meso form exists.

2 A four-step search

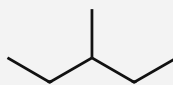
- **Step 1. Cross out** every carbon that cannot qualify: CH_3 , CH_2 , and sp^2 or sp carbons ($C=C$, $C=O$, $C\equiv C$).
- **Step 2. List the four groups** on each remaining carbon, including any H you would not normally draw.
- **Step 3. Compare whole branches.** Two identical groups (two CH_3 , two C_2H_5 , two identical ring paths) rule the carbon out.
- **Step 4. Star and count** the stereocentres that remain.



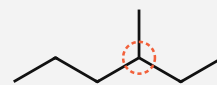
Butan-2-ol
1 stereocentre (C_2)



Alanine
1 stereocentre (C_α)



3-Methylpentane
none: two ethyl groups on C_3



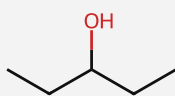
3-Methylhexane
1 stereocentre:
ethyl $\neq$ propyl

Ringed carbons are the stereocentres, found by computer (RDKit). These are the three molecules from the short, plus the trap's chiral cousin.

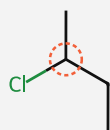
Careful: an sp^2 carbon is never a chiral carbon.

A carbon in a double bond carries only three groups and is flat. A C=C bond can still give cis/trans (E/Z) isomers, but that is geometrical isomerism, not a chiral carbon.

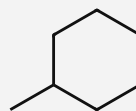
3 The traps that catch most students



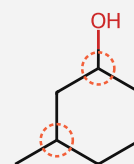
Pentan-3-ol
none: two ethyl groups on C3



2-Chlorobutane
1 stereocentre (C2)



Methylcyclohexane
none: both ring paths from C1 are identical



3-Methylcyclohexan-1-ol
2 stereocentres (C1 and C3)

Molecule	Looks chiral at	Why it is not
3-Methylpentane	C3	two identical ethyl groups
Pentan-3-ol	C3	two identical ethyl groups
Propan-2-ol	C2	two identical CH_3 groups
Methylcyclohexane	C1	the two ways round the ring are identical
Ethanal (CH_3CHO)	the CHO carbon	sp^2 carbon with only three groups

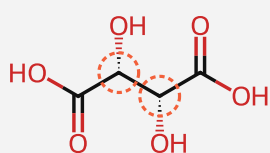
Rings: walk both ways round.

For a ring carbon, follow the ring in both directions. If both paths meet identical atoms all the way round, it is not a stereocentre (C1 of methylcyclohexane). If they differ anywhere, it is (C1 and C3 of 3-methylcyclohexan-1-ol).

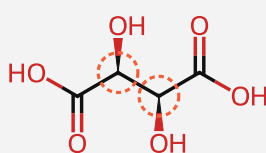
4 Counting stereoisomers: the 2^n rule and meso forms

Each stereocentre can be R or S, so n stereocentres allow up to 2^n stereoisomers. When the two halves of a molecule are identical, one combination is its own mirror image and the count drops.

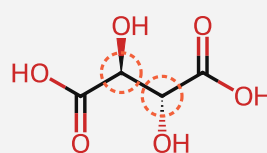
Molecule	Stereocentres (n)	Maximum 2^n	Actual stereoisomers
Butan-2-ol	1	2	2
2-Bromo-3-chlorobutane	2	4	4
Tartaric acid	2	4	3 (one is meso)
Open-chain aldohexoses (glucose family)	4	16	16



(2R,3R)-Tartaric acid
chiral



(2S,3S)-Tartaric acid
its enantiomer



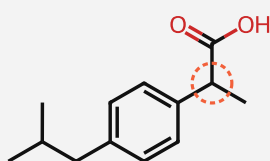
meso-Tartaric acid
(2R,3S): achiral, has a mirror plane

R/S labels and the meso symmetry checked by computer (RDKit, CIP rules).

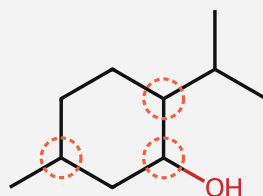
Why does the meso form appear?

In (2R,3S)-tartaric acid the top half is the mirror image of the bottom half. The molecule has an internal mirror plane, so it is identical to its own mirror image: achiral, even with two stereocentres.

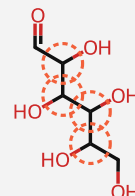
5 Stereocentres in real molecules



Ibuprofen
1 stereocentre: the (S) form is the active one



Menthol
3 stereocentres: 8 stereoisomers



Glucose (open chain)
4 stereocentres: 16 aldohexoses

Count them yourself first, then check against the rings. In ibuprofen, the CH attached to the ring, CH₃ and COOH is the only stereocentre; the CH of the isobutyl group carries two

CH₃ groups.

6 One-minute revision

1. Chiral carbon: sp³ carbon with four different groups.
2. Cross out CH₃, CH₂ and every sp² or sp carbon first.
3. Compare whole branches; for rings, walk both ways round.
4. n stereocentres give at most 2ⁿ stereoisomers.
5. Identical halves can give a meso form: stereocentres, yet achiral (tartaric acid has 3 stereoisomers, not 4).

Organic Pulse · free notes by Dr. Sandeep G. Sontakke. Main sources: OpenStax/LibreTexts *Organic Chemistry*, sections 5.2, 5.6 and 5.7; Clayden *et al.*, *Organic Chemistry* (2nd ed.), ch. 14. Every count on this page was checked by computer (RDKit).
Watch the shorts: youtube.com/@OrganicPulse-y9q