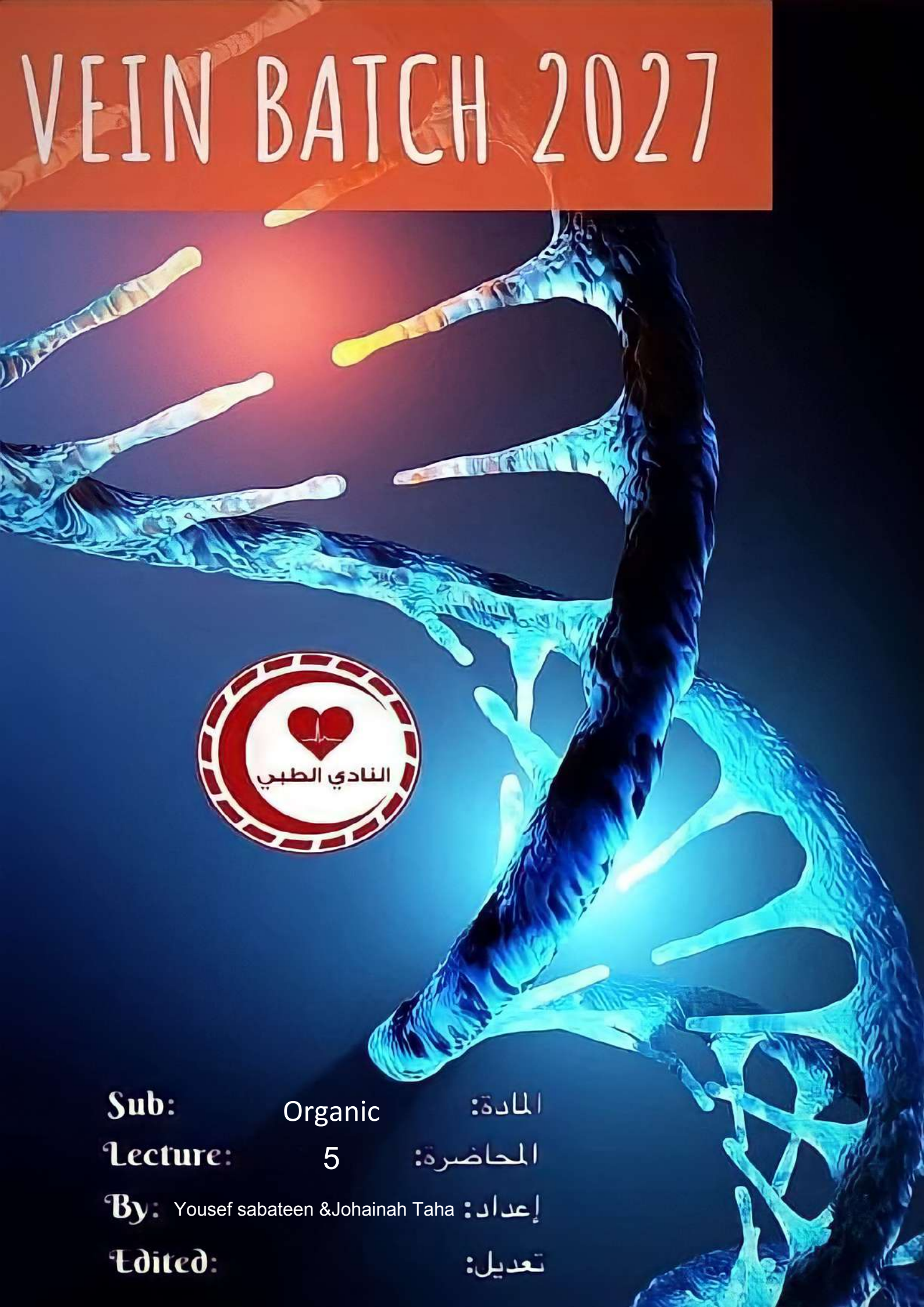
VEIN BATCH 2027



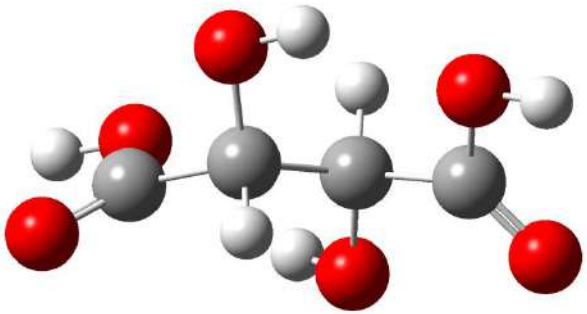
النادي الطبي

Sub: Organic المادة:

Lecture: 5 المحاضرة:

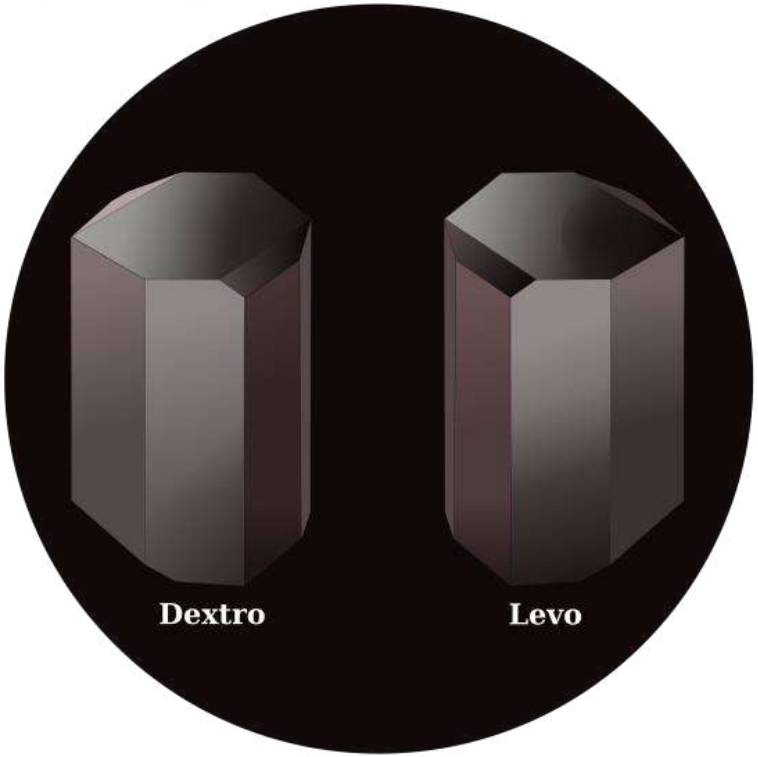
By: Yousef sabateen &Johainah Taha إعداد:

Edited: تعديل:

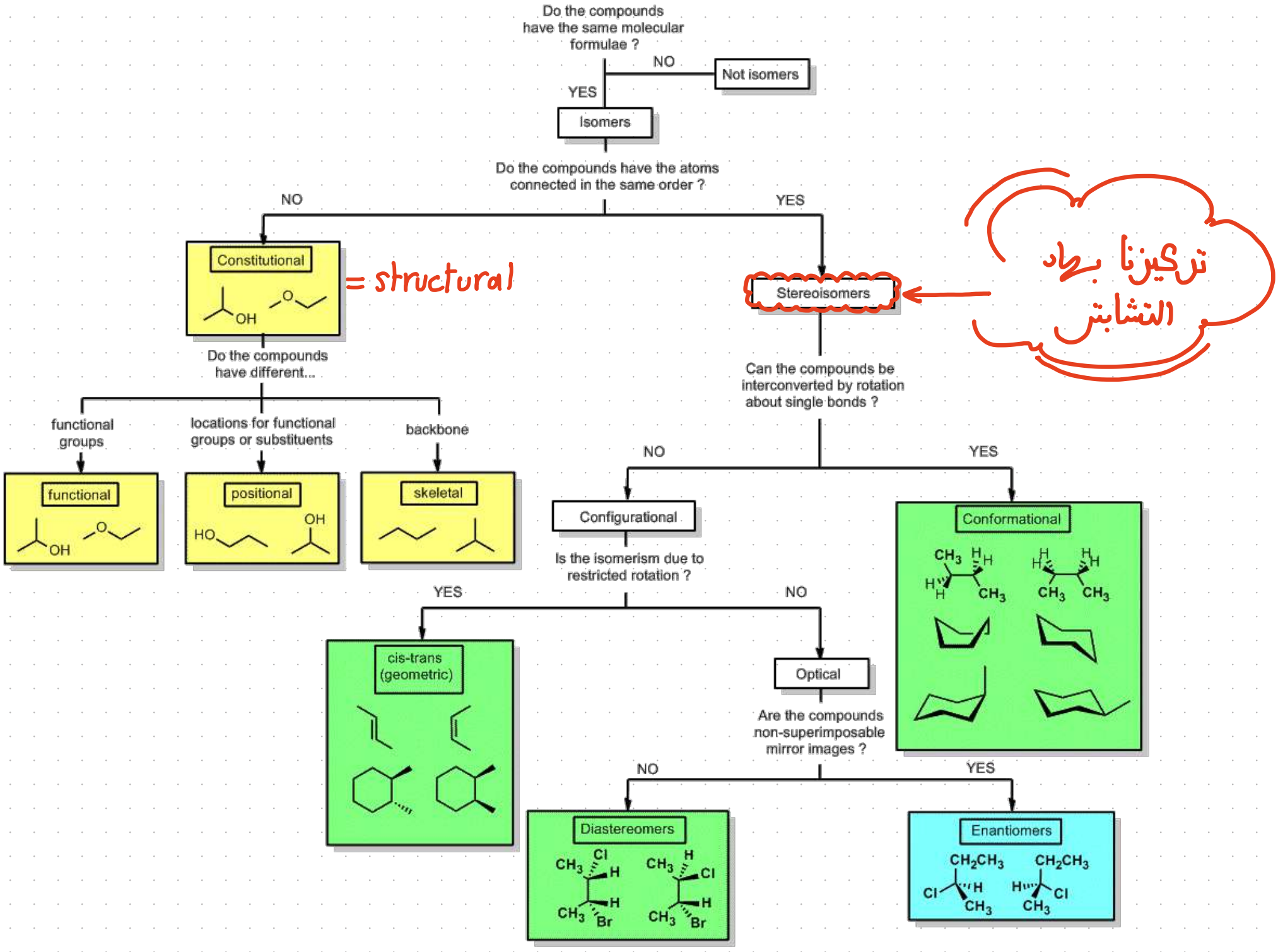


النادي الطبي

Chapter 5: Stereoisomerism



Done by :
Yousef Sabateen
Johainah Taha


Do the compounds have the same molecular formulae ?
NO
Not isomers
YES
Isomers
Do the compounds have the atoms connected in the same order ?
NO
YES
Constitutional
= structural
Stereoisomers
تركيزنا بهاد التشابتس
Do the compounds have different...
Can the compounds be interconverted by rotation about single bonds ?
functional groups
locations for functional groups or substituents
backbone
functional
positional
skeletal
NO
YES
Configurational
Conformational
Is the isomerism due to restricted rotation ?
YES
NO
cis-trans (geometric)
Optical
Are the compounds non-superimposable mirror images ?
NO
YES
Diastereomers
Enantiomers

Record 11

Stereochemistry

Stereochemistry is the study of the 3D aspects of molecules. ***Stereoisomers*** are molecules that differ only in the 3D arrangement of their atoms.

* الـ Steroisomer يختلف عن الـ conformer في ما بينتجوا بسبب عدم rotation حول الـ Segma .
* الـ Steroisomers الهم أنواع :-
  1. Chirality

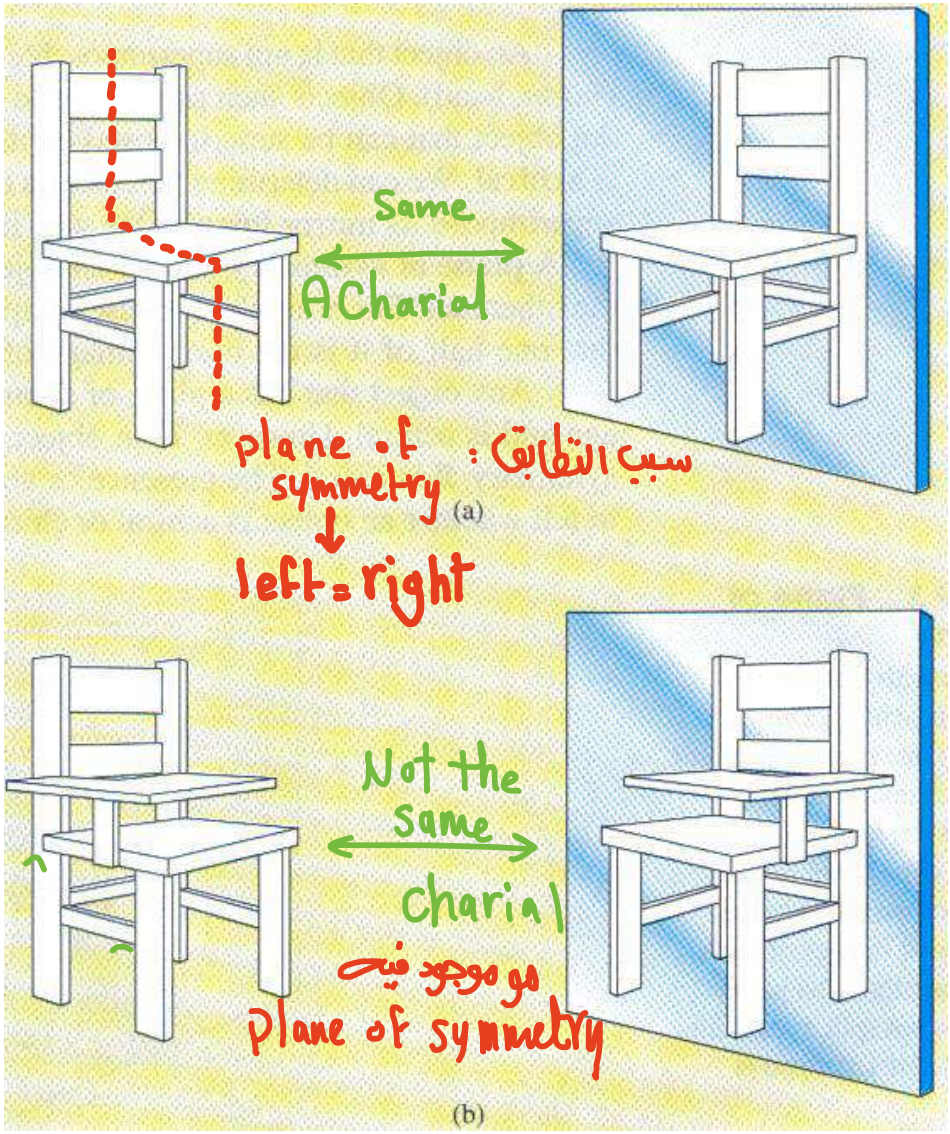
Record 11
2:18

Chirality →

Objects can be chiral or achiral, i.e.

The top chair is achiral (mirror image is superimposable)

The bottom chair is chiral (mirror image is not superimposable)



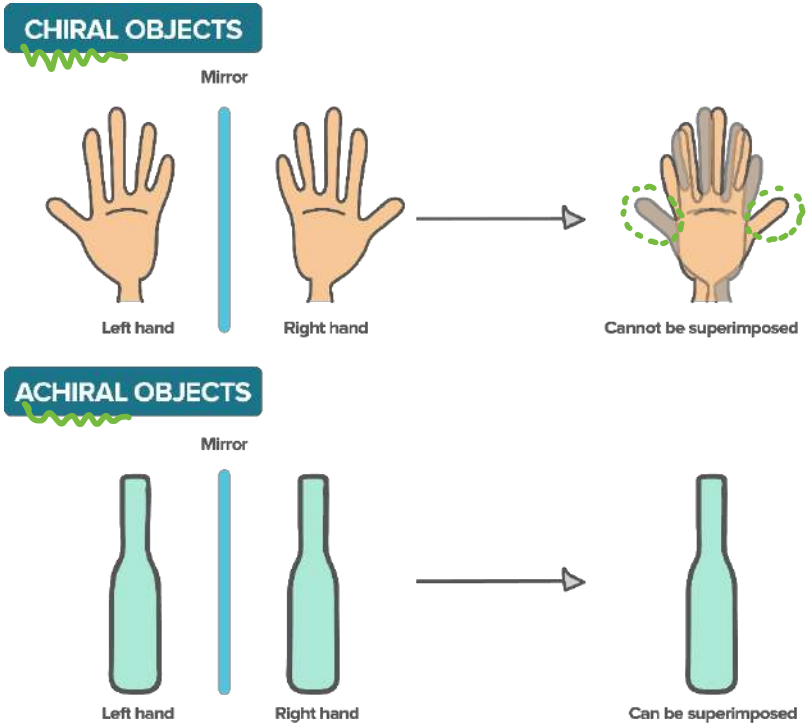
متشابه

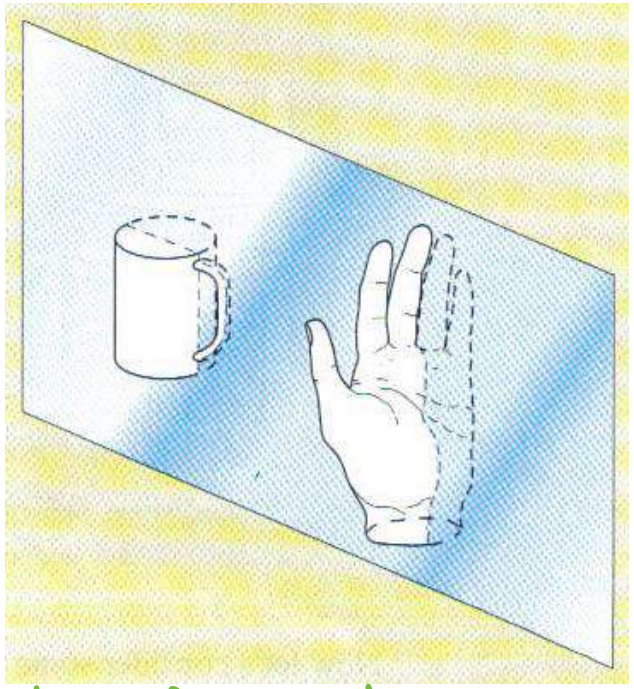
Right = left

An achiral object will have a ***plane of symmetry*** in it, i.e. a mirror plane through the object so that one half is a mirror image of the other.

The coffee cup is achrial

While the hand is chiral





plane of symmetry:

يكون قطع بالمنتصف و يتساوى

الطرف اليمين بالشمال.

Chirality

Chiral

- غير متطابق
- not superimposable
- no plane of symmetry
- Pair of enantiomers

Achiral

- متطابق
- superimposable
- Has a plane of symmetry.

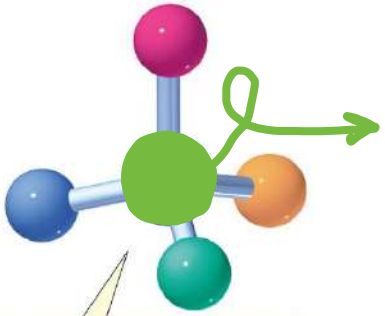
Stereoisomers posses one or more chiral centers. Chiral objects are ones where the mirror image has a different 3D structure, i.e. the mirror image is not superimposable on the original object.

For molecules a chiral center is an sp^3 hybridized C atom with four different groups (atoms) attached. If two or more groups are identical then the molecule will posses a plane of symmetry.

Record 11.
7:20

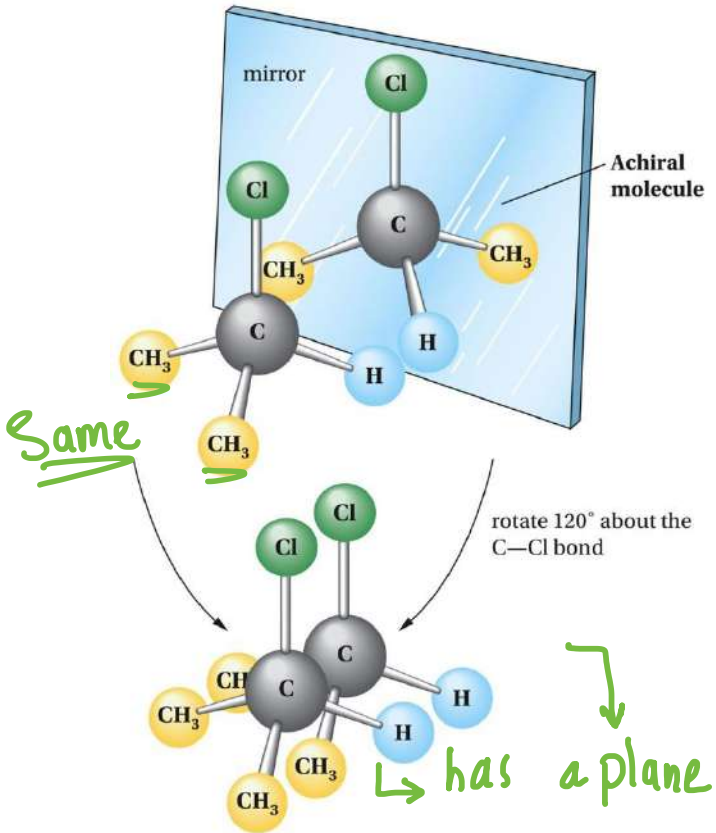
Chiral شروط

1. sp3 atom
2. attached to 4 different atoms.



↳ Chiral

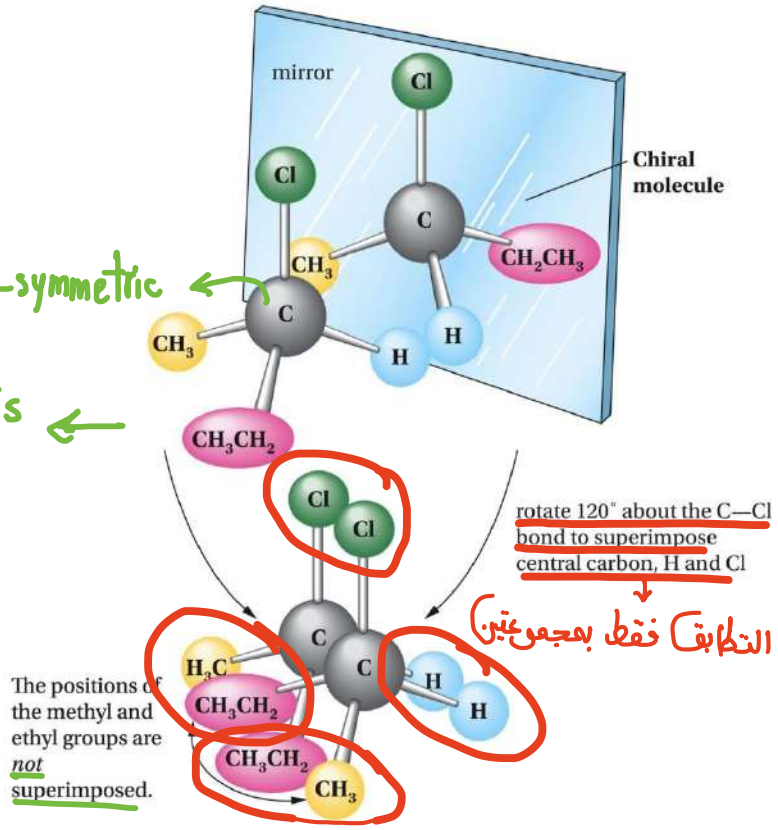
هاي الكربونة الها عدة أسماء:
Chiral carbon
Asymmetric carbon
Stereogenic Centre



Same

↳ has a plane of symmetry.

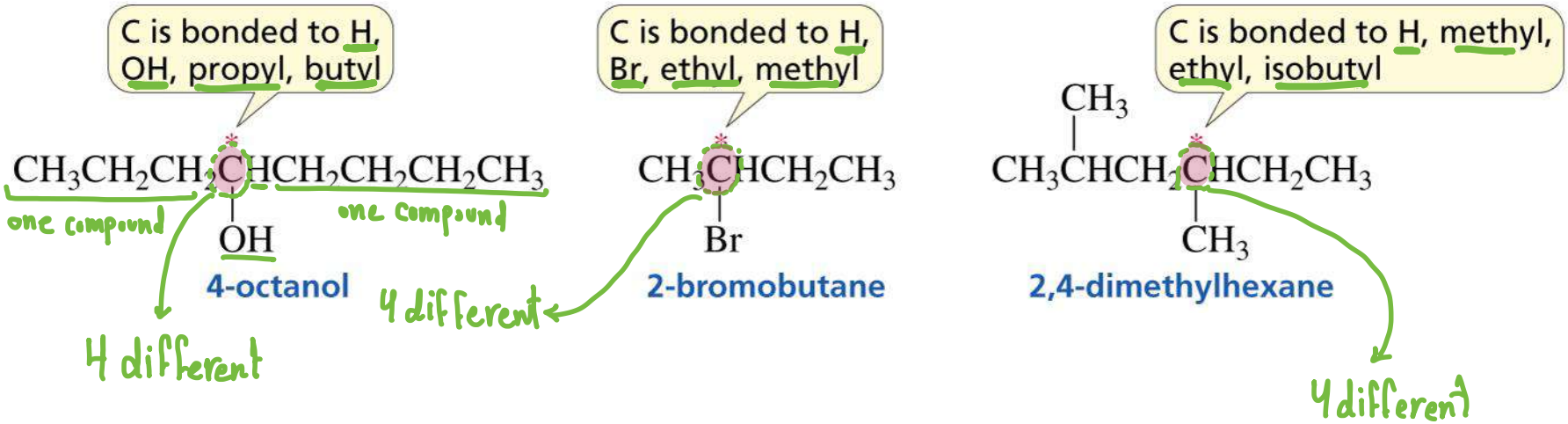
Stereoisomers ←



q-symmetric ←

التطابق فقط بمجموعتين

Compounds with an Asymmetric Center



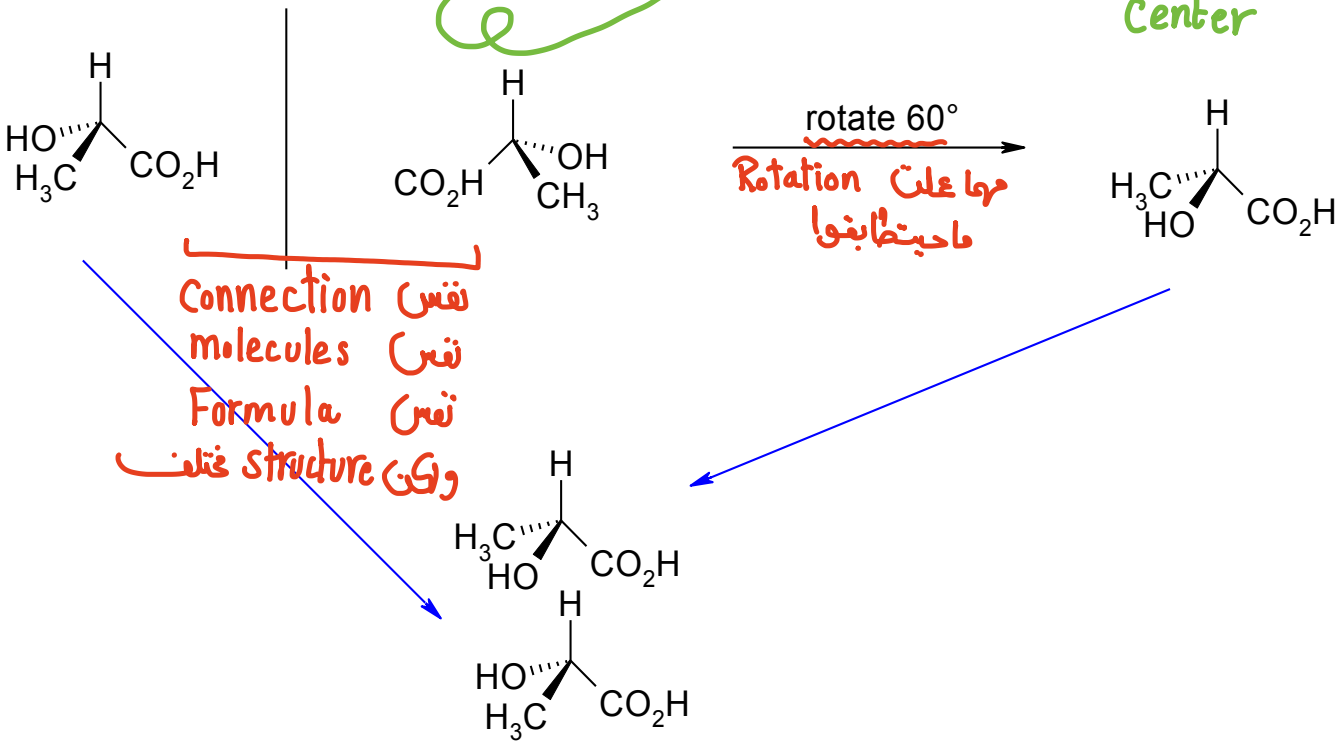
SP_3 التهجين

Record 11
16:30

Chirality (cont'd)

Molecules which are non-superimposable mirror images (because they have a chiral or stereogenic center) are *enantiomers*, i.e.

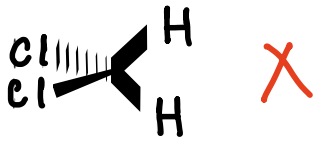
enantiomers = chiral = stereogenic center = mirror like

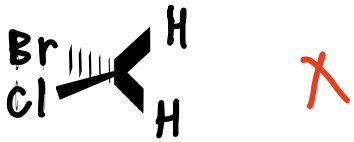


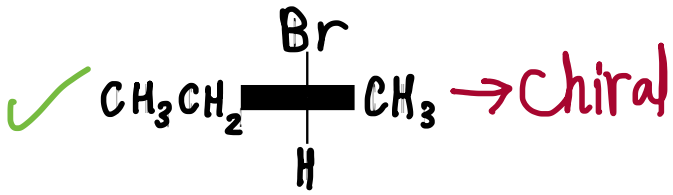
Enantiomers (cont'd)

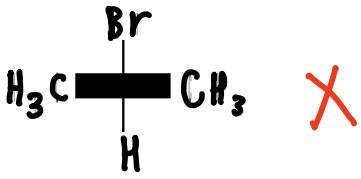
قاعدة
لوكان عنا assymetric على طول بكون عشي Chiral

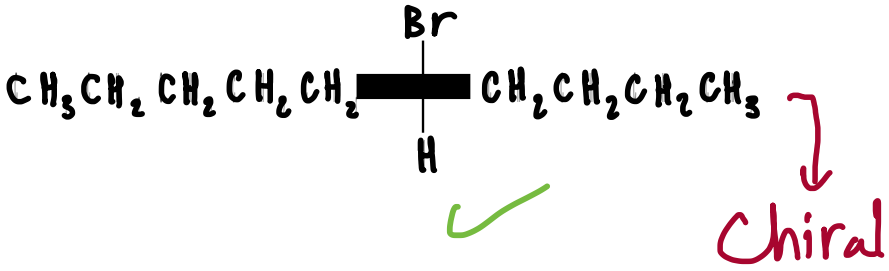
Chiral or not?

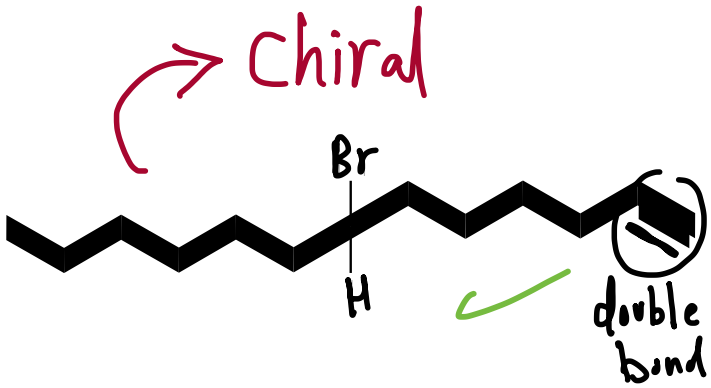






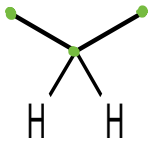




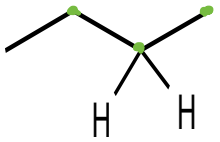


Chemically Equivalent Atoms

Atoms that are related to one another by a mirror plane are chemically equivalent and have the same chemical properties, i.e. propane and butane



homotopic H



enantiotopic H

Record 11
18:00

. Chiral Carbon للتسمية

Configuration: R/S Nomenclature

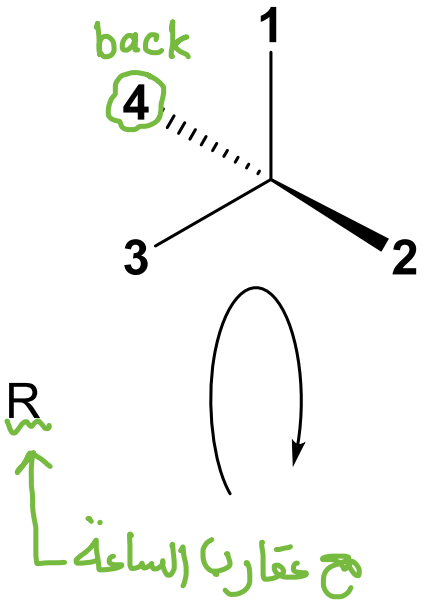
التعيين

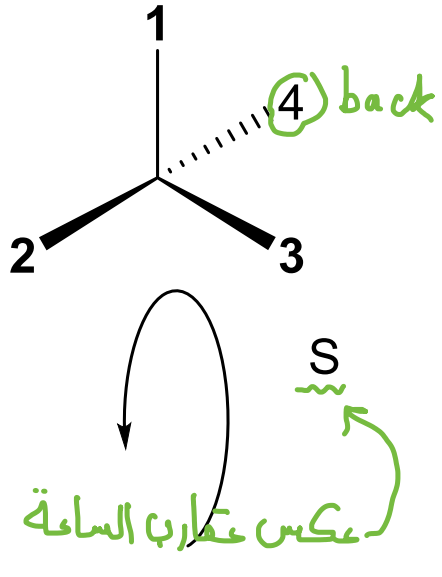
The R/S nomenclature system is used to distinguish between two enantiomers. The methods relies on three simple rules for assigning priority to the four groups attached to assign a configuration of R (clockwise) or S (counterclockwise).

تعيين أولوية

* للتفريق بين 2 enantiomers

The lowest (#4) priority group Pointing away from us (.....)

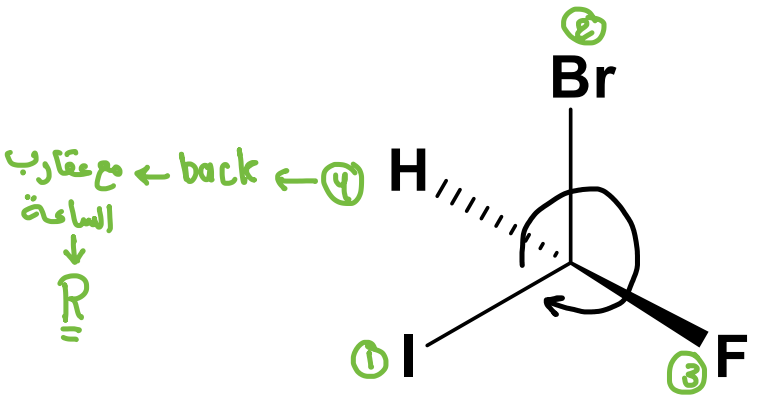




The rules are:

1) Atoms attached to the stereogenic center are ranked to atomic numbers (the higher the atomic number the higher the priority

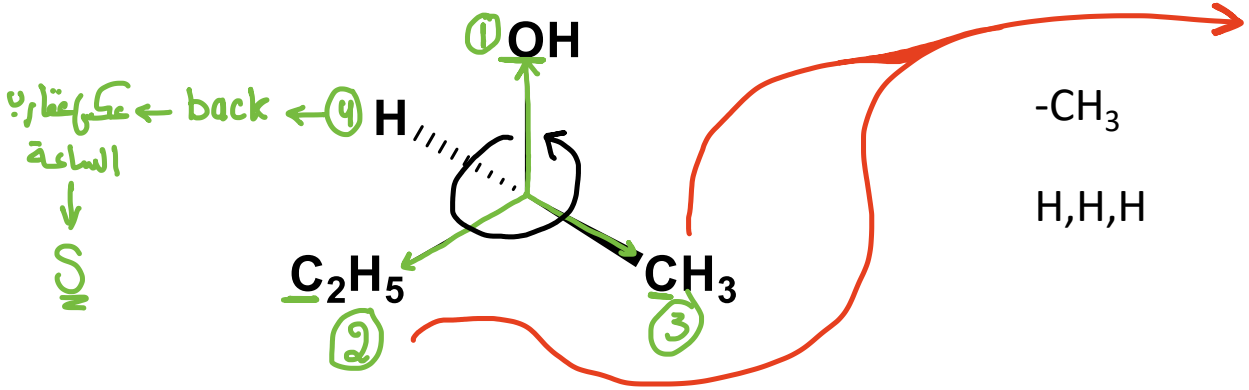
Note : دائمًا لو وجدت الهيدروجين فرقمها هو ٤



higher atomic number → I, Br, F, then H → lower atomic number

2) Compare the next atom out in the chain

في حالة تشابه ال atoms زي الايثيل و الميثيل
بشوف كمان كل c بمين شابكة
بنلاحظ انه كربونة الميثيل شابكة ب 3H
و كربونة الايثيل شابكة ب 2H - 1C
فالأولوية حتكون ل الايثيل

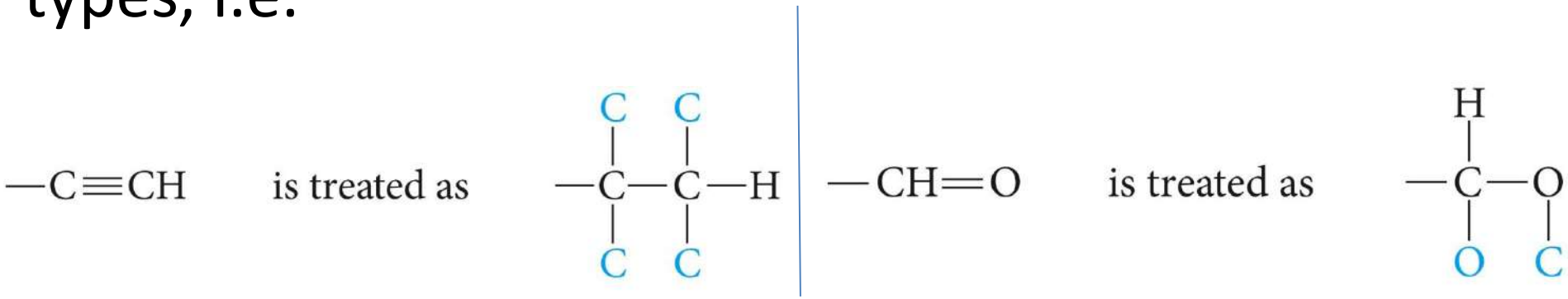


$-CH_3$ vs. $-CH_2CH_3$

H,H,H H,H,C

Higher priority

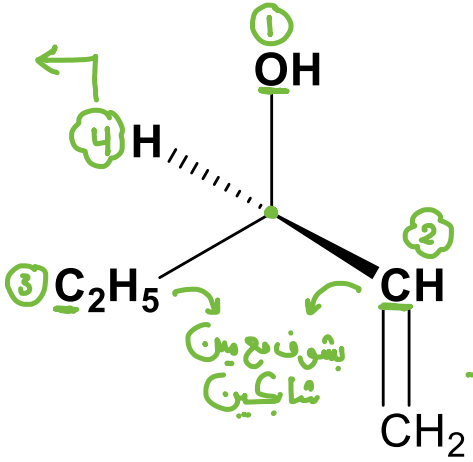
3) Multiple bonds: open the bond as equivalent atom types, i.e.



مع عقارب الساعة ← back ←

R

eg R Or S



بشوف مع مين شابكين

رابطتين يعني هي شابكة مع C مرتين → الأولوية لط

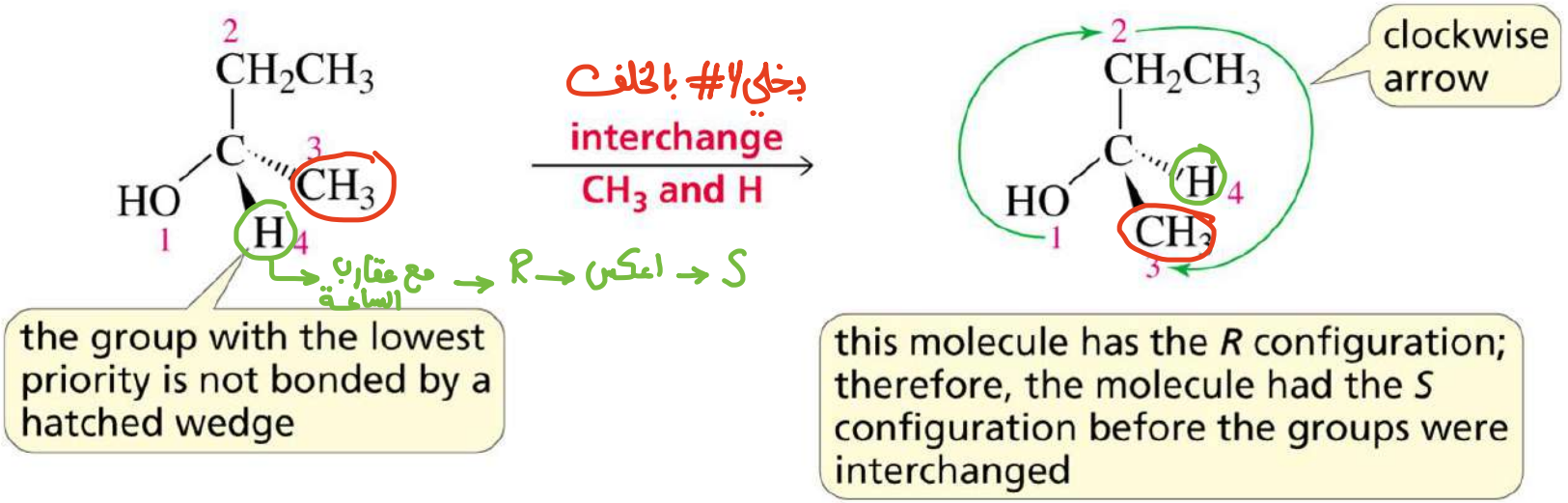
Record 11
39:00

Naming Enantiomers

لوكانت H مو موجودة على back ← بنعمل rotation وبعكس

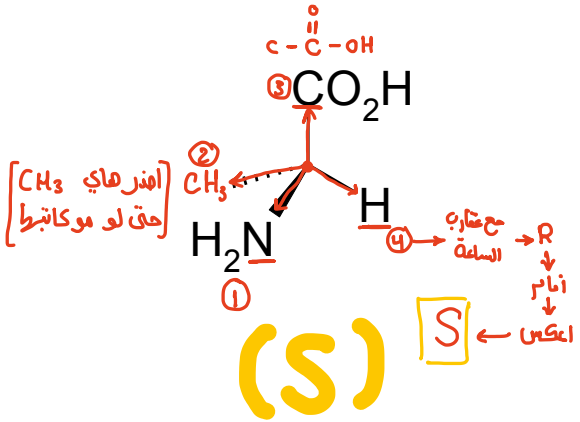
If the lowest priority group is not on a hatched wedge (#4), switch a pair so it is on a hatched wedge.

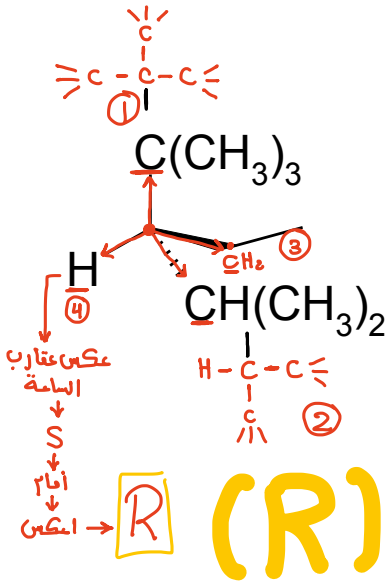
Then, name the new compound.

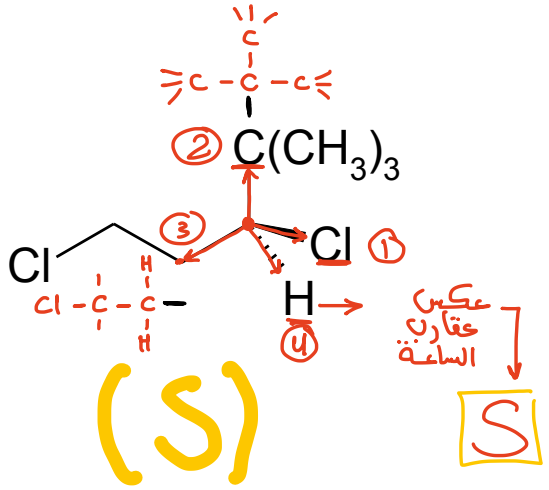


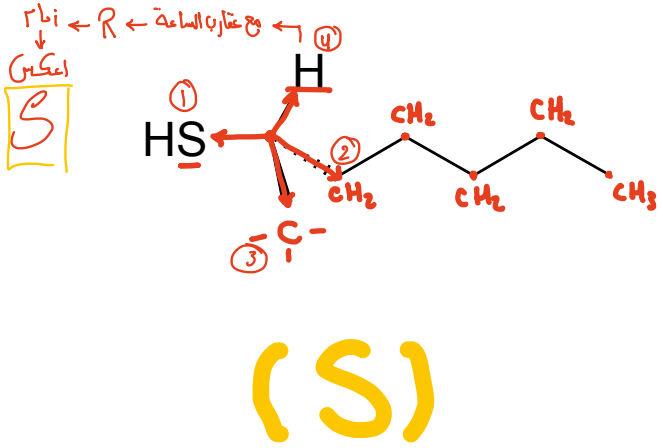
Configuration: R/S Nomenclature

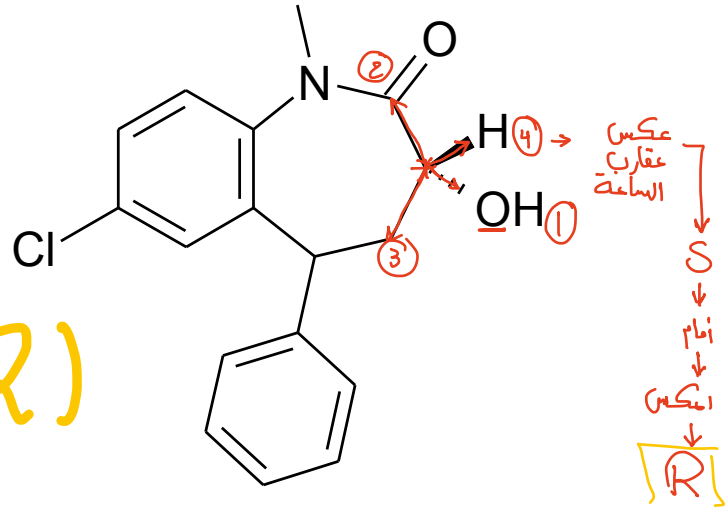
Examples:











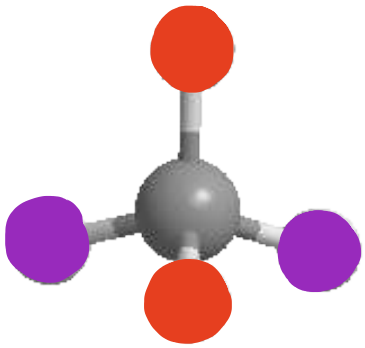
Record 12

Fisher Projections

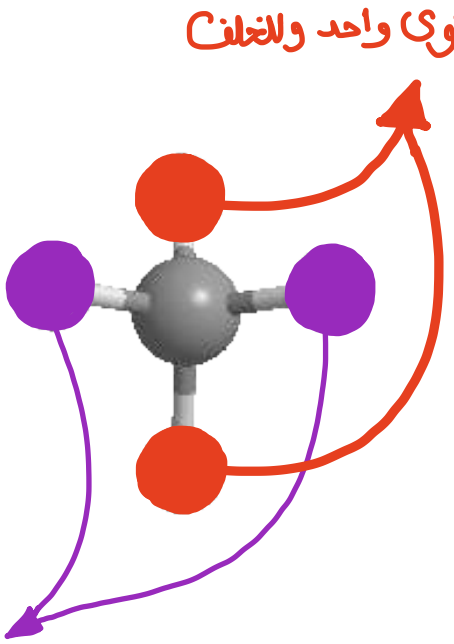
نقل وتحويل

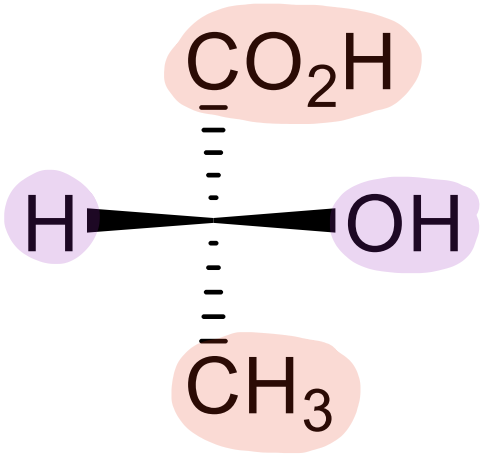
Fisher projections are a stylized way of conveying 3D info in a 2D drawing. They are very common in biochemistry. The convention is a cross where the horizontal arms are coming out of the page towards you and the vertical arms are going back into the page. For 2 adjacent chiral centers the middle vertical bond is in the plane of the page, i.e.

الاتفاقية عبارة عن صليب حيث تخرج الأذرع الأفقية من الصفحة نحوك والأذرع الرأسية تعود إلى الصفحة. بالنسبة إلى مركزين متجاورين متجاورين ، تكون الرابطة الرأسية الوسطى في مستوى الصفحة



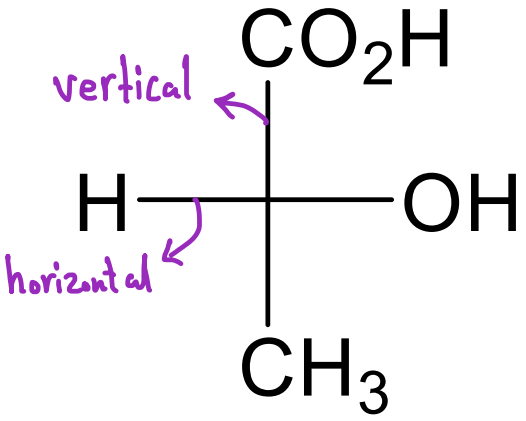
3D


على مستوى واحد وللخلف
على مستوى واحد وبرا


CO2H
H
OH
CH3

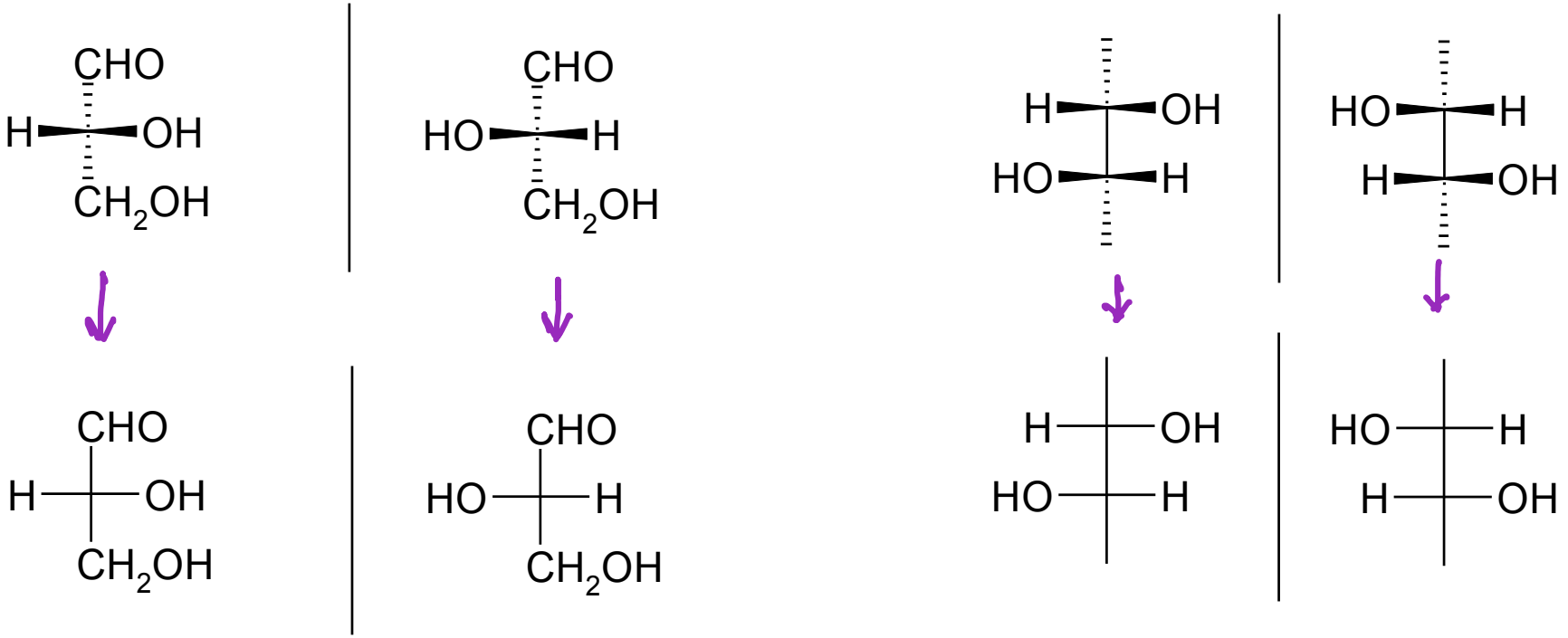
2D

=


CO2H
vertical
H
OH
horizontal
CH3

Fisher Projections

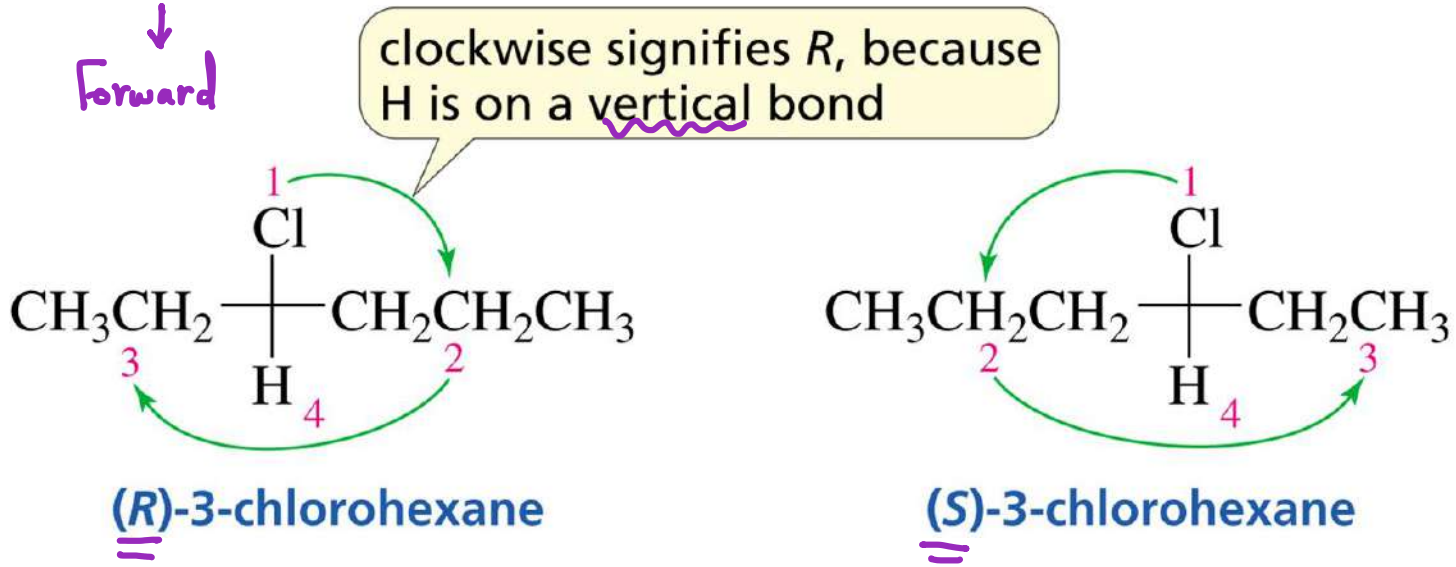
Examples:



note
H
verticle → back
horizontal → Forward

Naming Enantiomers

R or S



If the lowest priority group is on a vertical bond, then

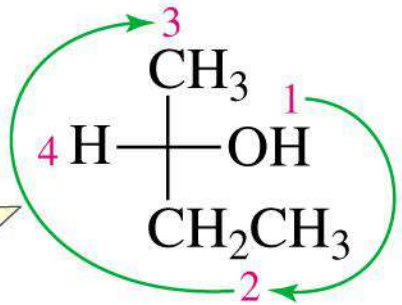
clockwise = *R*

and

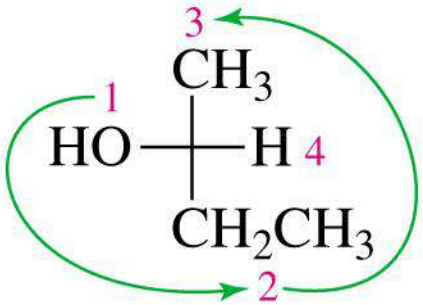
counterclockwise = *S*

Naming Enantiomers

clockwise signifies *S*,
because H is on a horizontal bond



(*S*)-2-butanol



(*R*)-2-butanol

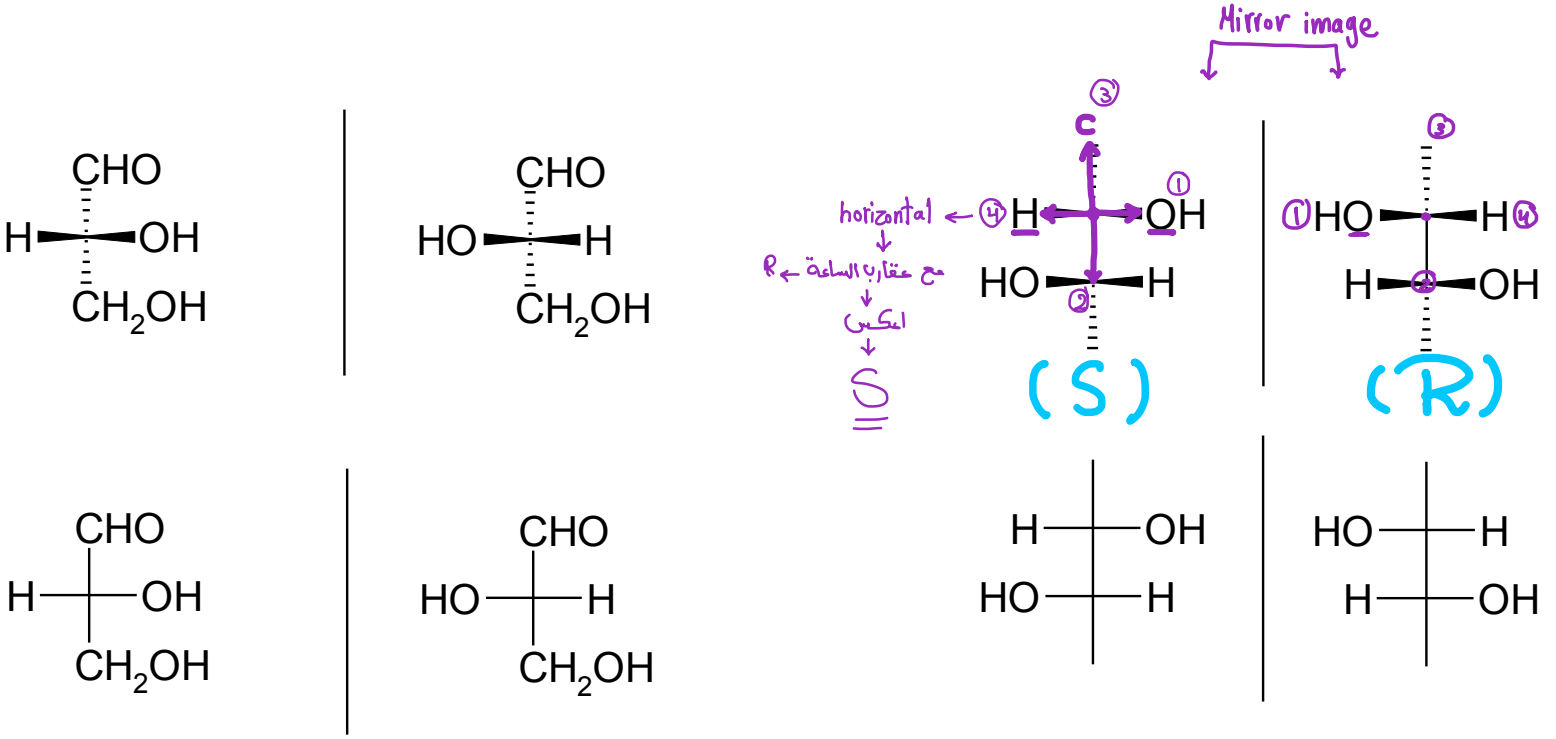
If the lowest priority group is on a horizontal bond, then

counterclockwise = *R*
and
clockwise = *S*

Record 12
8:00

Fisher Projections

Assign the following stereochemistry



D-glyceraldehyde

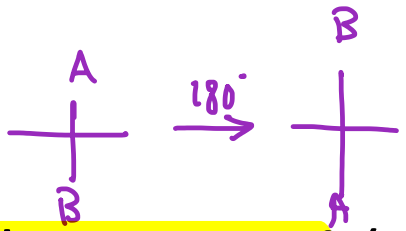
L-glyceraldehyde

S,S-butane-2,3-diol

R,R-butane-2,3-diol

الشمين طلعت ن الحمدلله

Fisher Projections



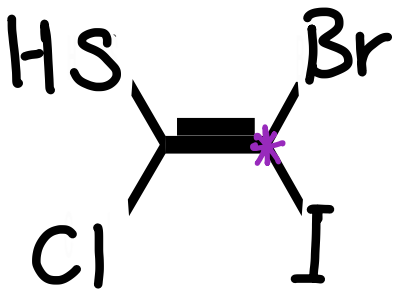
Manipulating Fisher diagrams:

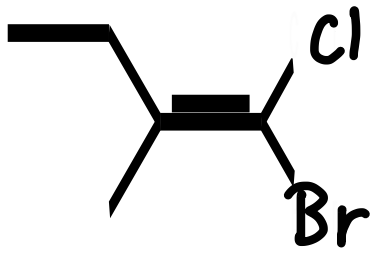
- Entire diagram: Rotation by 180° but not 90° (90° inverts the configuration)
- Three groups: can be rotated by any amount
- Two groups: exchange of any two groups inverts the configuration

Record 12
13:00

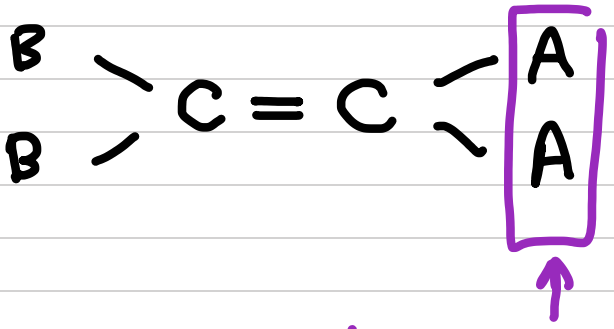
5.4: Configuration: E/Z Nomenclature

We have already seen geometric isomers when we discussed cyclic alkanes, the cis-/trans- isomers. Generally cis & trans only refer to hydrocarbons, what happens for other non C & H systems?

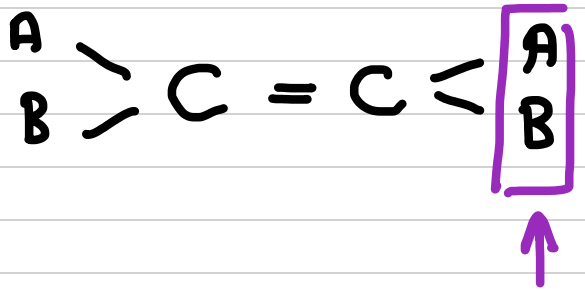




حكينا سابقاً بـ cis/trans isomer انه المهم شرط ، بتتذكروه ؟ طيب تعالوا أذكركم
هاد الشرط إنه كل C مرتبطة مع مجموعتين مختلفات عن بعض .

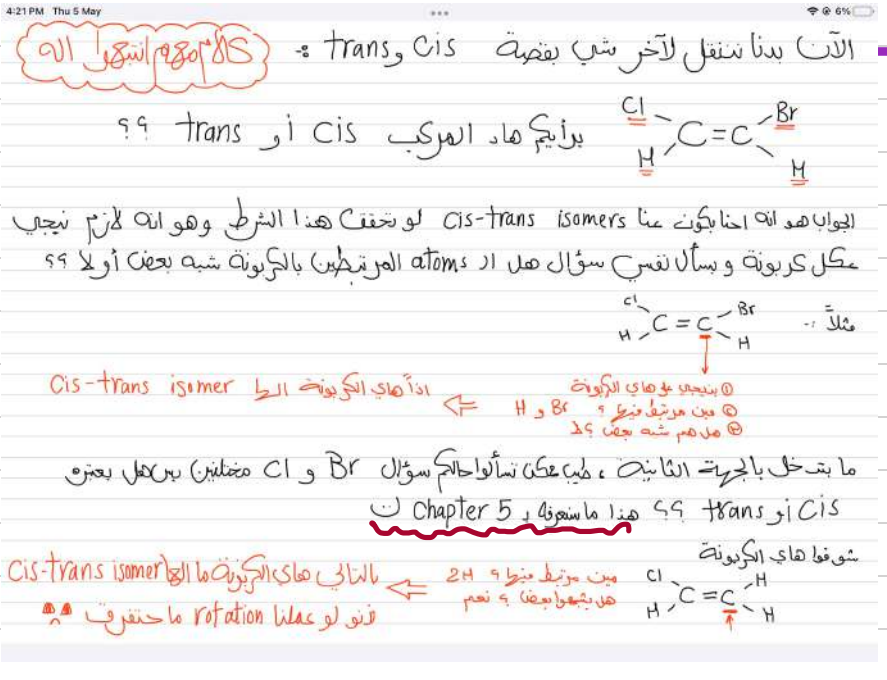


cis/trans isomer لها



cis trans isomer لها

الآن حان الوقت لنحدد إذا ال isomer هو cis أو trans



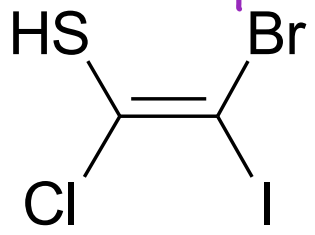
من Chapters

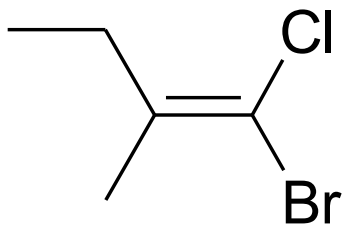
Configuration: E/Z Nomenclature

trans isomer ← → cis isomer

In this case we can use the same rules for chiral centers to assign a priority to each group on the double bond. When the two high priority groups are on the same side of the double bond: Z (zusammen (together)), on opposite sides: E (entgegen (opposite)).

priority حسب ترتيب، Carbon الي عنفس الـ atoms حنقارن بين الـ

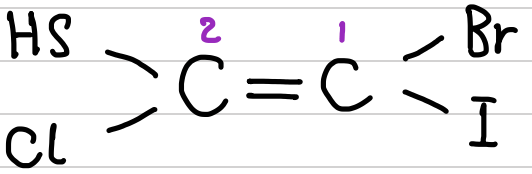




شرح الأمثلة

(*E*)-1-bromo-1-chloro-2-methylbut-1-ene

مثال ①



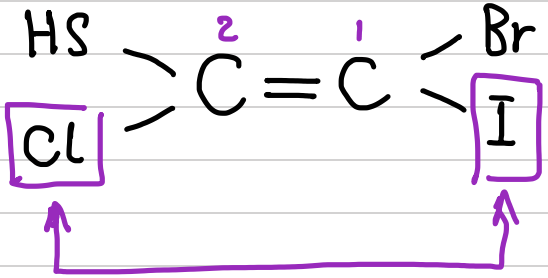
١. بسأل حالي سؤال ، هل C1 مرتبطة بـ atoms مختلفين ؟ yes

هل C2 مرتبطة بـ atoms مختلفين ؟ yes

٢. عند C1 مين أعلى ، priorety ، Br أو I ؟ I

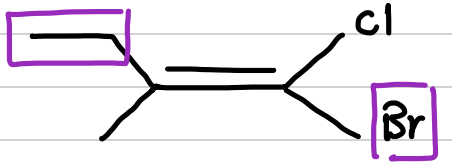
وعند C2 مين أعلى ، S أو Cl ؟ Cl

** الأولوية حسب مين أعلى atomic number



Cis or Z isomer ← مع بعض

مثال ②



trans or E isomer ← عكس بعض

في كمان موضوع ترجمناه من Chapter 3 الدكتور حكالنا حنوخده بتشابتر 5 :

Record 12
18:00

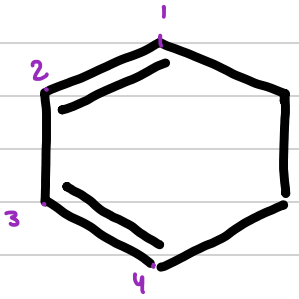
(2E) Oct-2-en-6-yne

بالأحمر

CH_3 — C2 = C3 — H

H

$C_4 - C_5 - C_6 \equiv C_7 - C_8$



1, 3 - cyclohexadiene

$CH_2 = \overset{2}{C}(CH_3) - CH = CH_2$

2_methyl_1,3 Butadiene

2double bond يعني عندي

Record 12
24:00

stereoisomers اصناف

Enantiomers

Definition: non-superimposable mirror images.

- Identical non-chiral properties, i.e. MP or BP, interaction with other non-chiral objects/molecules

. Enantiomer بتكون متشابهة بين Melting point / boiling point *

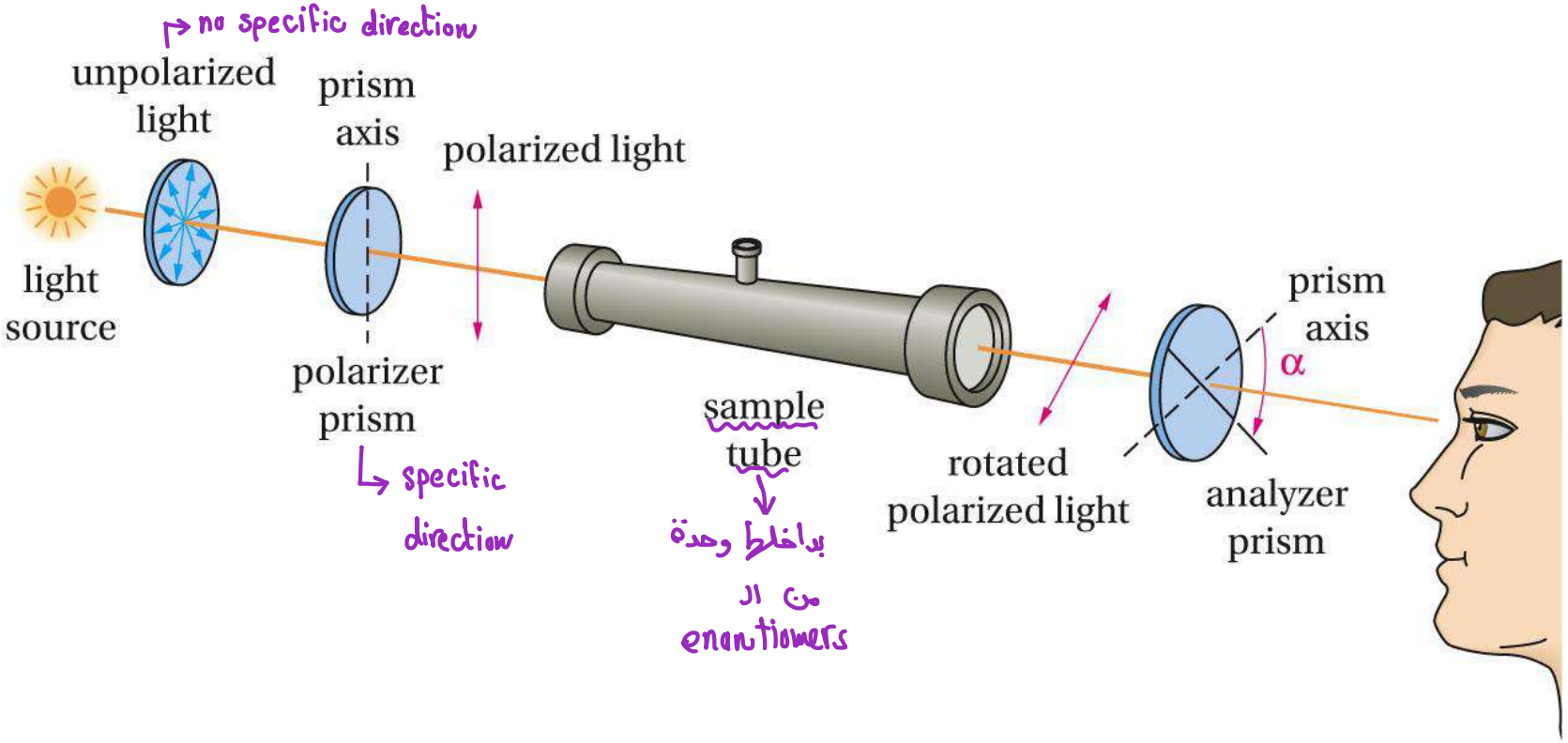
- Different chiral properties, i.e. optical activity, interactions with other chiral objects/molecules

Record 12
26:00

∴ enantiomers الاختلاف الاذ ل بين

Optical Activity

The experiment is performed using a polarimeter.



Optical Activity → تجربة عملية

Optical activity refers to a molecule's ability to interact with plane polarized light (PPL). Optically active compounds will rotate PPL due to the electron distribution in the molecule either clockwise (dextrorotatory (+)) or counterclockwise (levorotatory (-)).

← الاشارة تدل على الاتجاه

* if the sample was chiral, the light will rotate

بالنسبة لعين الناظر ← clockwise → dextro (+)

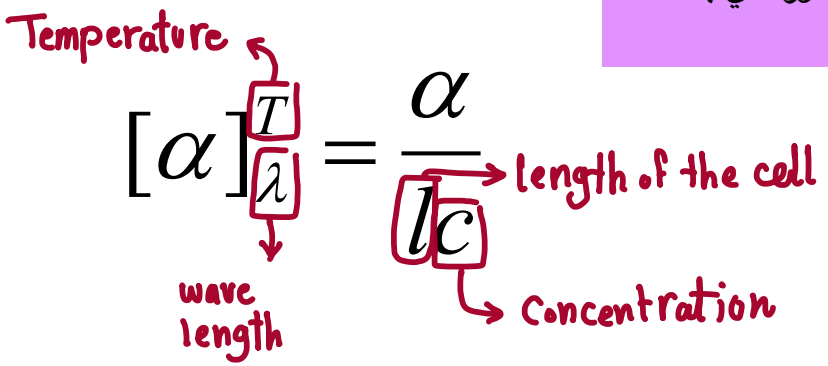
counterclockwise → levo (-)

ملاحظة: سواء كان clockwise أو counterclockwise ستكون ∝ الرقم نفس القيمة.

Optical Activity

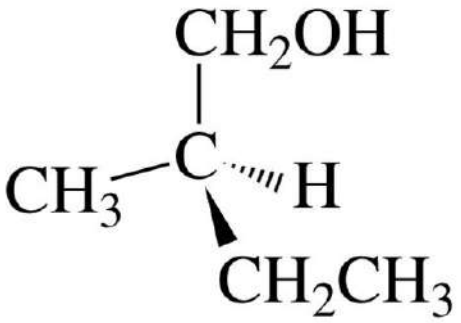
The polarimeter measures the observed rotation (α, degrees), but since the rotation is dependent on the concentration, temperature, wavelength of light and device it is more common to report the ***specific rotation***, where *l* is the pathlength through the polarimeter and *c* is the concentration.

المطلوب منا هو معرفة الامور الي بتعتمد عليها قيمة الفا (الزاوية)



If One Enantiomer is (+), the Other is (–)

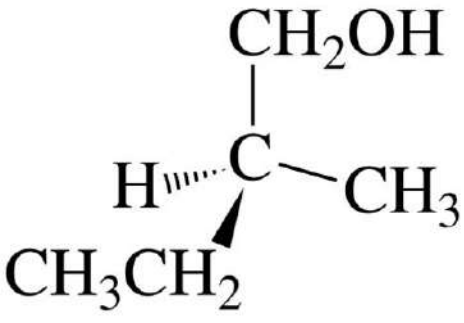
Pair of enantiomer



(*R*)-2-methyl-1-butanol

$$[\alpha]_D^{20\,^\circ C} = \oplus 5.75$$

d → مع عقارب الساعة



(*S*)-2-methyl-1-butanol

$$[\alpha]_D^{20\,^\circ C} = \ominus 5.75$$

l → عكس عقارب الساعة

نفس القيمة ولكن الاختلاف بالاتجاه

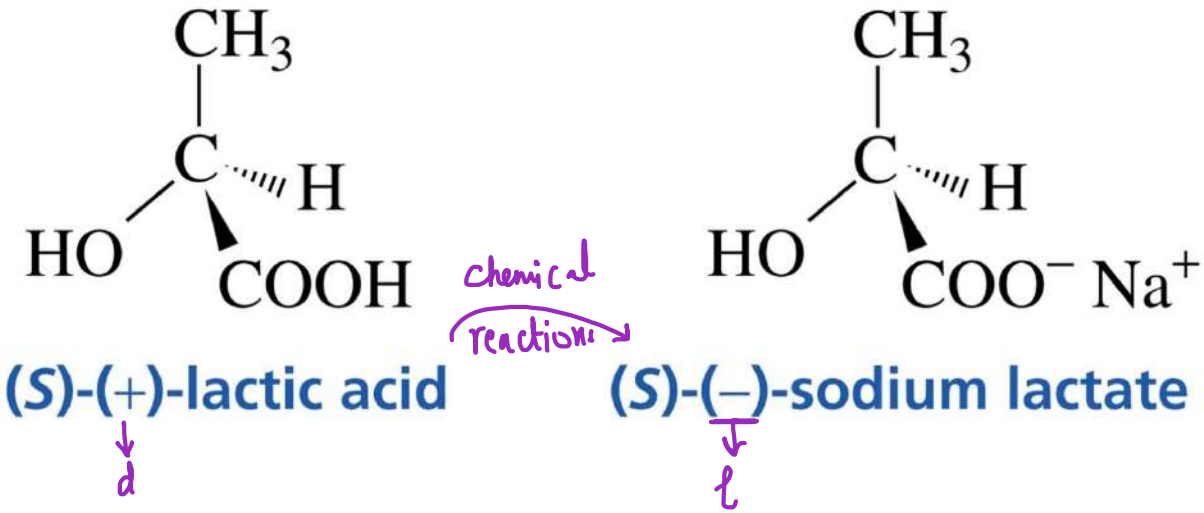
R and *S* *versus* (+) and (–)

There is no relationship between (R/S) and (+/ -)

الدكتور كثير شدد عليها

Some *R* enantiomers are (+) and some are (–).

Some *S* enantiomers are (+) and some are (–).



الـ R و S بنحددهم عن طريق Rules تعلمناهم ، مع عقارب الساعة أو عكس حسب الأولوية وقصة انه #4 بالخلف أو الأمام .

أما d و l عبر التجربة العملية فنقفل الناظر بشوف مع أو عكس عقارب الساعة

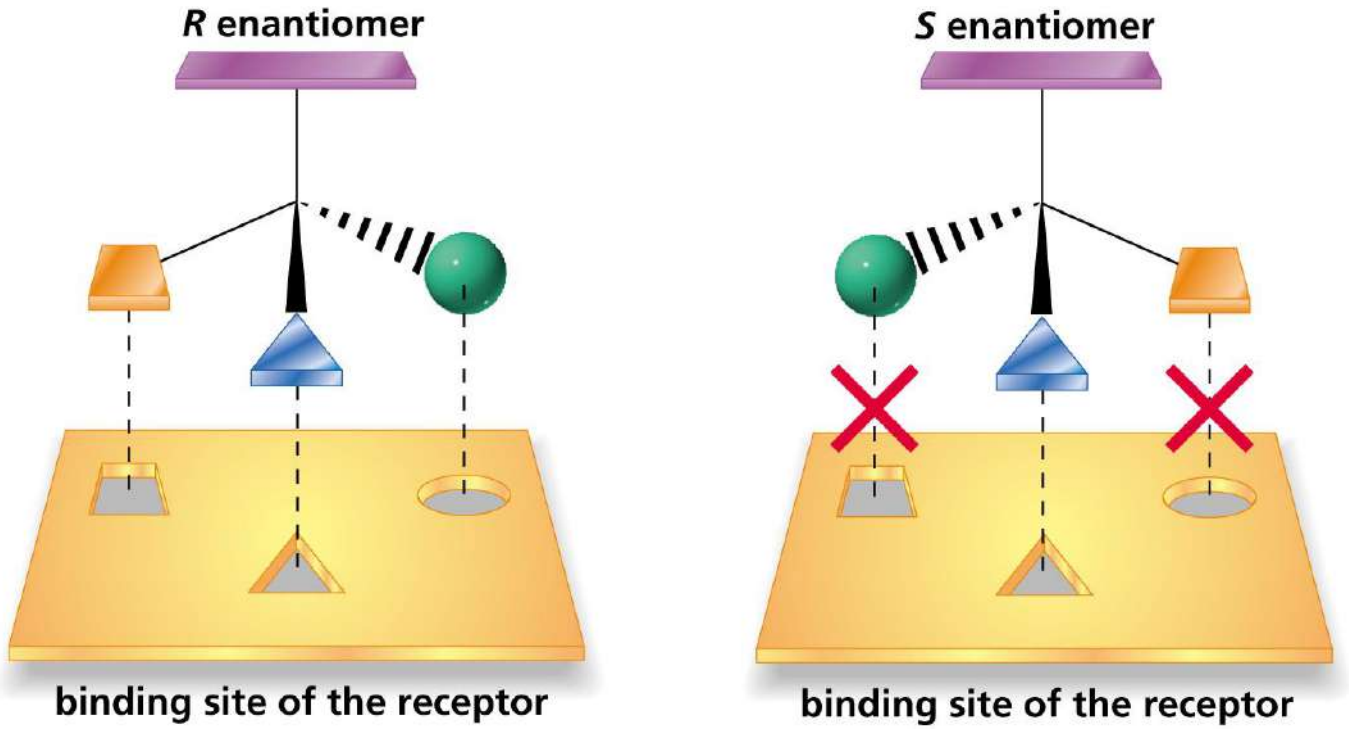
Record12
36:30

Biological properties of enantiomers

A Receptor is a Protein
Proteins are Chiral Molecules

Because a receptor is chiral, it binds one enantiomer.

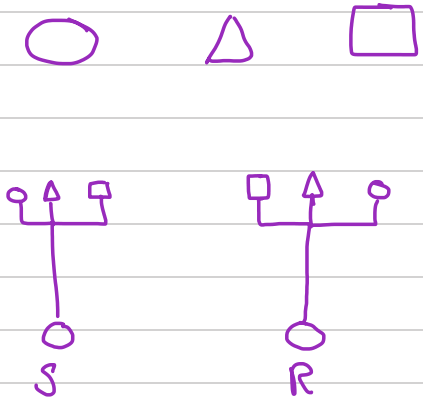
A right-handed glove fits only a right hand.



* بعض الـ enantiomers المهم Biological properties ، مثلاً ممكن R Enantiomer يستخدم كـ Drug والـ S لا يستخدم بأي شي.
رغم إنه الفرق بينهم هو بالـ Structure فقط.

* سبب هاد الكلام لهم الـ Receptors بكونوا Chiral

مثال

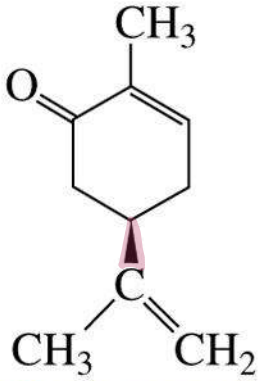


برأيكم مين
حيركب عالـ Receptor؟
(S)

هاد المطلوب منا فقط

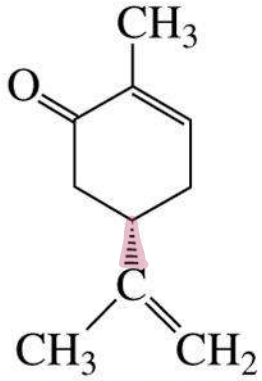
A Receptor Binds One Enantiomer

(*R*)-(–)-carvone
smells like
spearmint



(*R*)-(–)-carvone

$[\alpha]_D^{20\,°C} = -62.5$



(*S*)-(+)-carvone

$[\alpha]_D^{20\,°C} = +62.5$

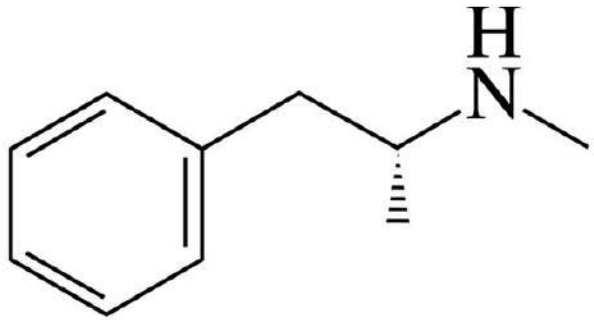
(*S*)-(+)-carvone
smells like
caraway seeds

receptor هدول مثلاً بختلفوا بالرائحة وكل واحد الـ

Each enantiomer binds to a different receptor in the nose.

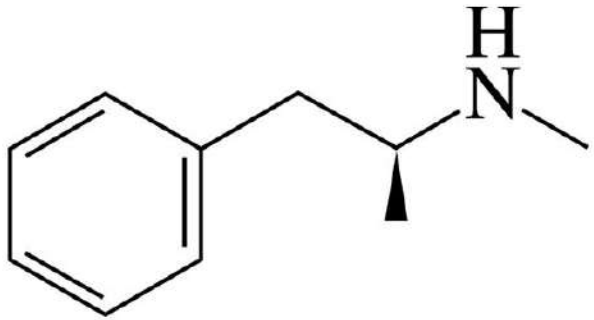
Physiological Properties of Enantiomers

Enantiomers can have very different physiological properties.



the active ingredient in Vicks Vapor Inhaler®

هاد فعلاً بكون active أثناء العلاج

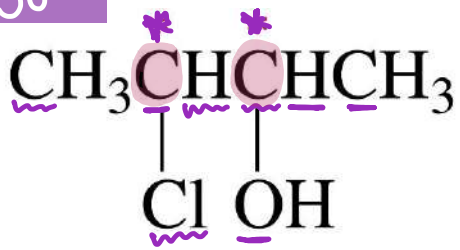


methamphetamine "meth"

هاد ما الله تأثير بالعلاج

Compounds with Two Asymmetric Centers

Record 12.
40:30

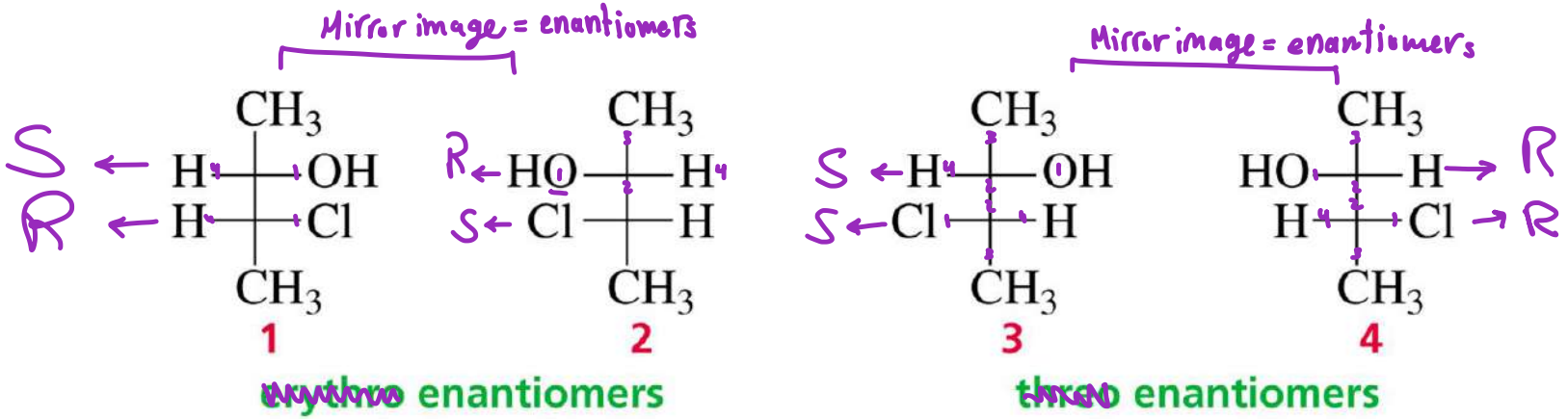


3-chloro-2-butanol

maximum # of stereoisomers = 2^n

(n = # of asymmetric centers)

* الاحتمالات ستكون RR, SS, SR, RS

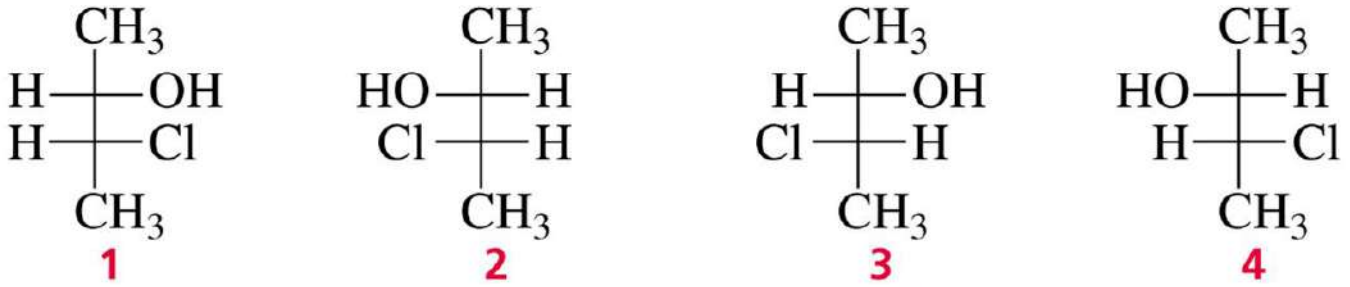


Fischer projections of the stereoisomers of 3-chloro-2-butanol (eclipsed)

1 and 2 are enantiomers.

3 and 4 are enantiomers.

Diastereomers



Fischer projections of the stereoisomers of 3-chloro-2-butanol (eclipsed)

1 and 2 are enantiomers.

3 and 4 are enantiomers.

Diastereomers are stereoisomers that are not enantiomers.

→ not mirror image

1 and 3 are diastereomers.

1 and 4 are diastereomers.

2 and 3 are diastereomers.

2 and 4 are diastereomers.

Diastereomers have different physical and chemical properties.

Diastereomers

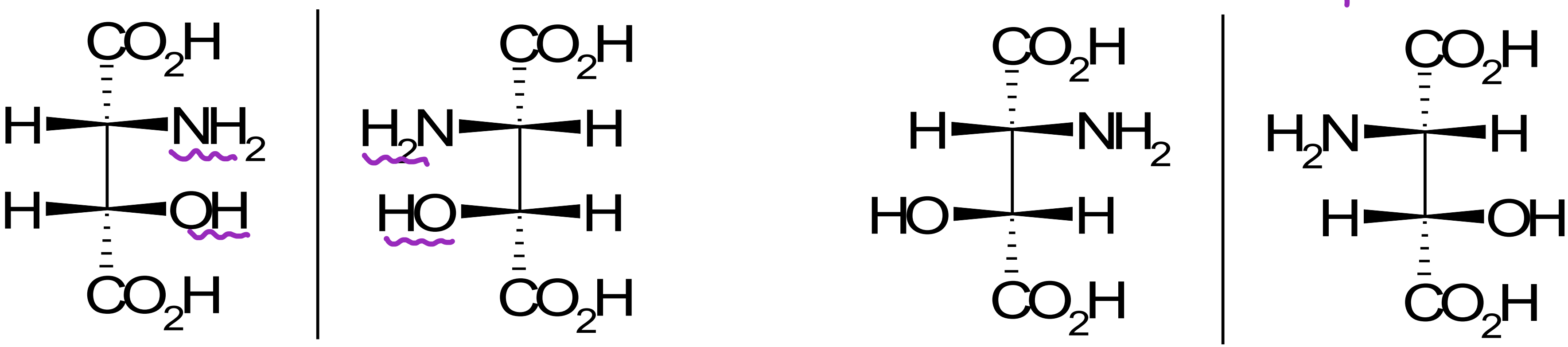
Diastereomers are an additional class of stereoisomers. In contrast to enantiomers (non-superimposable mirror images) diastereomers are non-superimposable non-mirror images. This means they need to have two or more chiral centers (and/or geometric (E/Z) isomeric centers).

Diastereomers

→ there is No plane of symmetry

Nonequivalent stereogenic centers:

enantiomers   enantiomers



2R,3R   2S,3S   2R,3S   2S,3R

رقم C

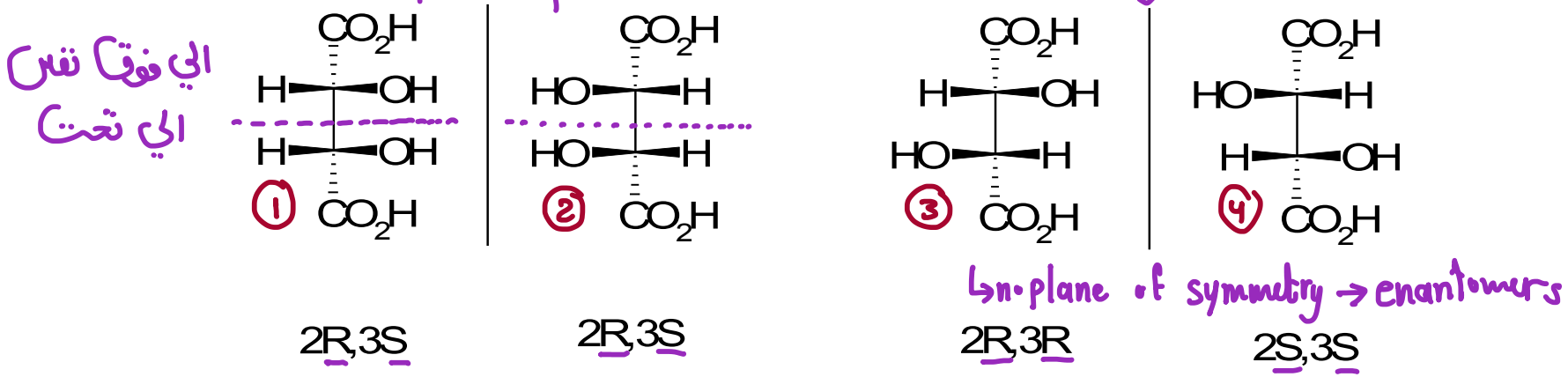
Diastereomers: Meso compounds

plane of symmetry

Equivalent stereogenic centers:

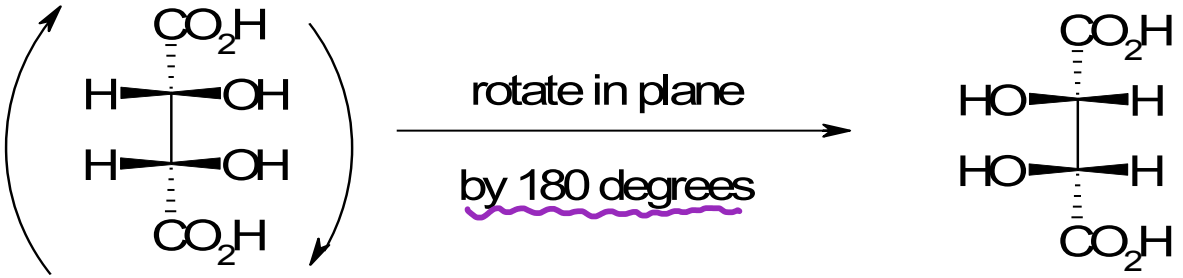
بنسمية

identical → there is a plane of symmetry



no plane of symmetry → enantiomers

distereomers ← ④ , ③ مع Meso علاقة ال



Diastereomers: Meso compounds

Equivalent stereogenic centers: meso compounds, although they contain multiple chiral centers, there are two configurations that are mirror images and superimposable, This results from the fact they contain a plane of symmetry

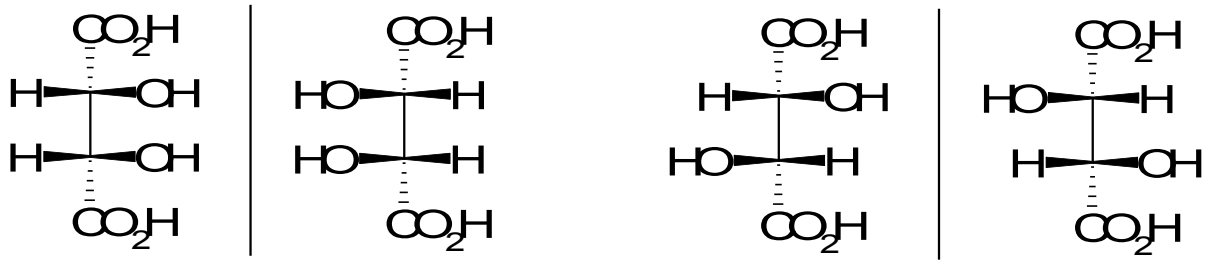
ولهذا زمان حكينا إنه

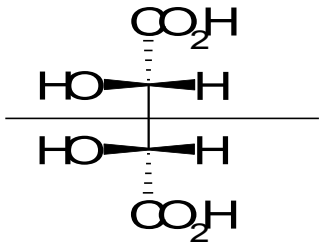
Max #of stereoisomers

$= 2^n$

فوشرط يطلع جد بهالعدد

ممكن يطلع أقل ...





plane of symmetry

اي فوق = اي تحت

Diastereomers

The physical and chemical properties of diastereomers are different.

For meso compounds two isomers are actually enantiomeric so they will have the same non-chiral properties but different chiral properties. The meso isomers will have different physical and chemical properties to the other isomers.

Stereochemistry in Chemical Reactions

Stereochemistry is very important in chemistry as you are normally only interested in one of the stereoisomers.

There are two possibilities:

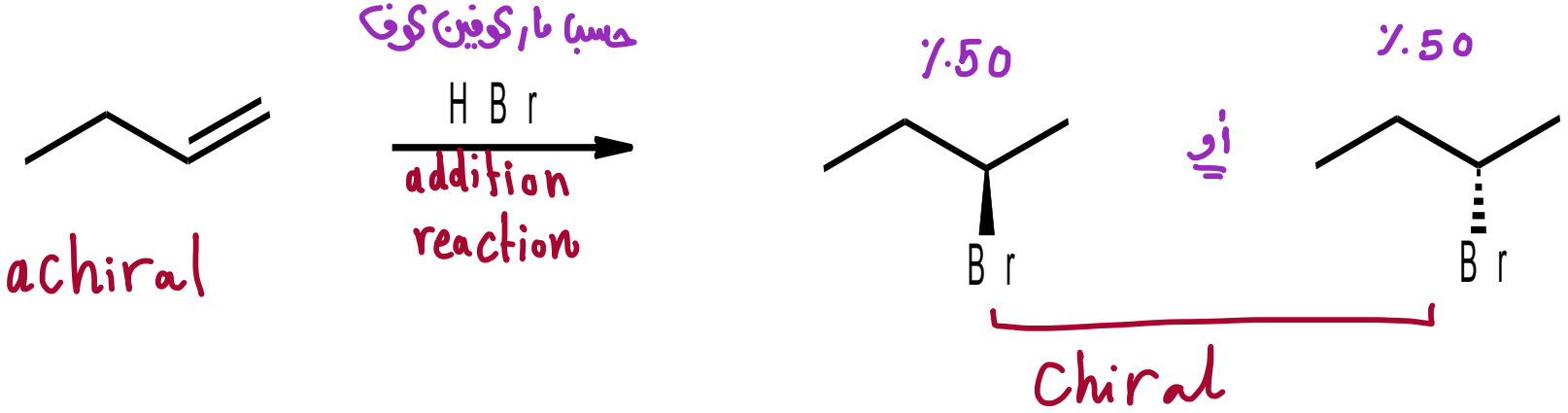
1. Chiral products from achiral reagents → مثال السلايد التالي
2. Chiral products from chiral reagents → مثال السلايد الي بعد التالي

Stereochemistry in Chemical Reactions

Chiral products from achiral reagents:

This commonly results from addition type reactions that go through a carbocation intermediate, equal chance of reacting with either side of the carbocation. Usually results in a racemic mixture (50:50) of both enantiomers, i.e.

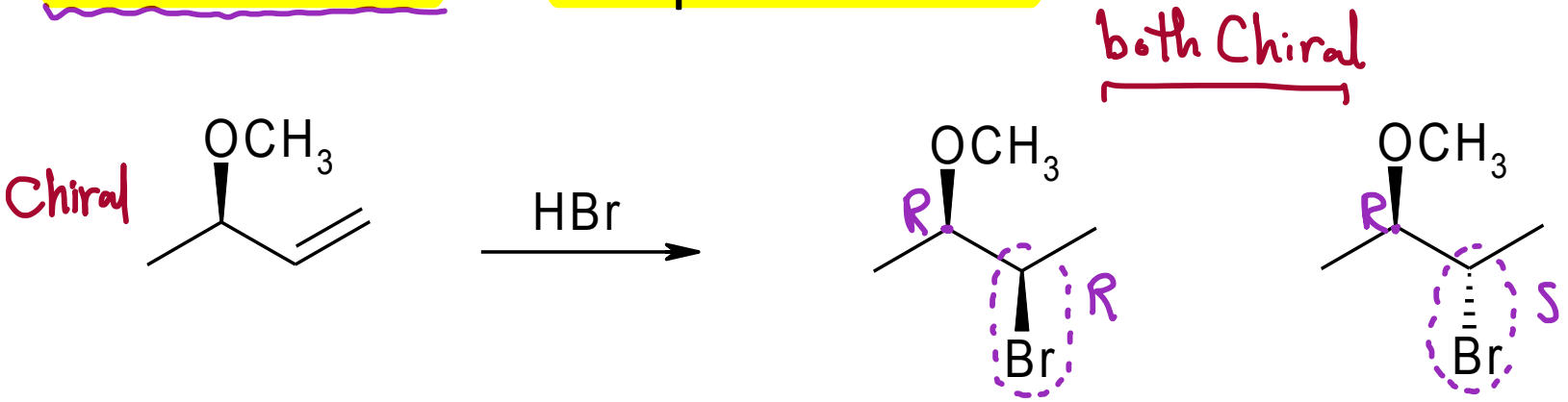
↳ pair of enantiomers + optical inactive
1 : 1 نسبتهم لبعض



Stereochemistry in Chemical Reactions

Chiral products from chiral reagents:

Since the chiral reagents react with each other at different rates this results in the production of diastereomers in unequal amounts. i.e.



50:50 **mixture** of two enantiomers

Racemic Mixtures

(optically inactive)