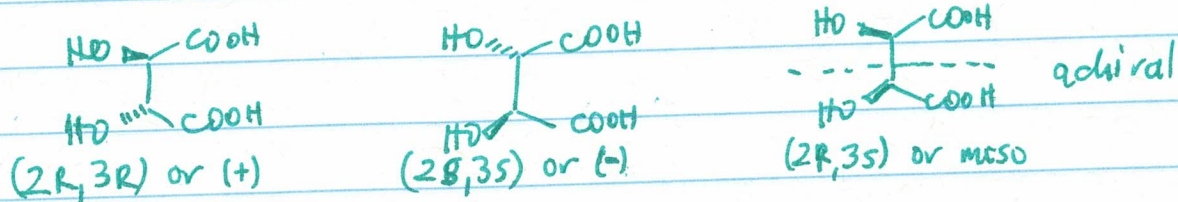


Lecture XIII: Diastereomers in Cpd's w/ Multiple Stereocenters

02-12-2020

Enantiomeric relationships are a special case of stereoisomerism in which the two isomers look like mirror images of each other. Diastereoisomers are all other stereoisomers. Today we will discuss only those diastereomers that are observed in compounds with multiple chiral elements.

Tartaric acid is an example:



With  $n$  stereocenters, one can have a maximum of  $2^n$  diastereomers but the existence of meso-isomers often extensively lowers that number. Meso-compounds are compounds that have multiple chiral centers but are still achiral.

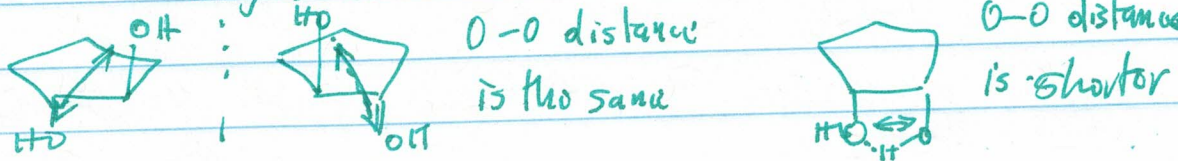
Diastereomers have different physicochemical properties from one another they are often as different as constitutional isomers:

mp (+ or - tartaric acid) = 171-174°C

" (racemate) = 206°C

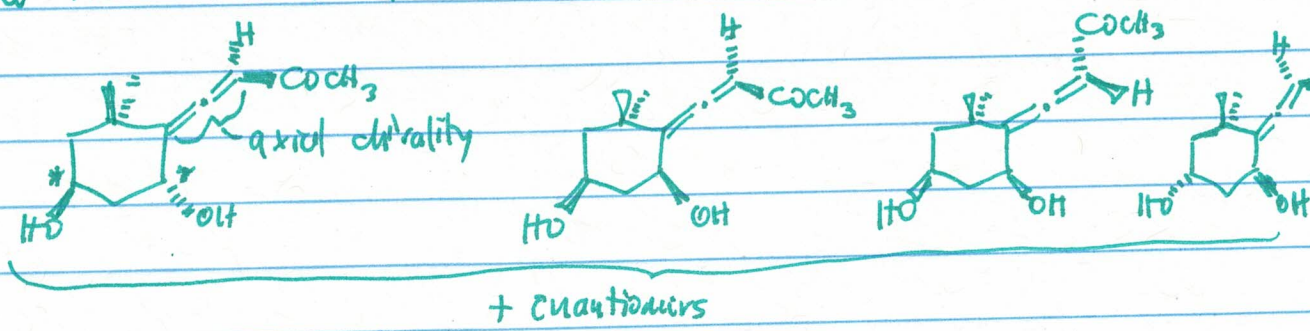
" (meso) = 165-166°C

Why do diastereomers have different properties, and enantiomers don't? It has to do with the concept of isometry. In enantiomers all distances and angles are the same; they are non-superimposable isometric mirror images. Diastereomers are anisometric:



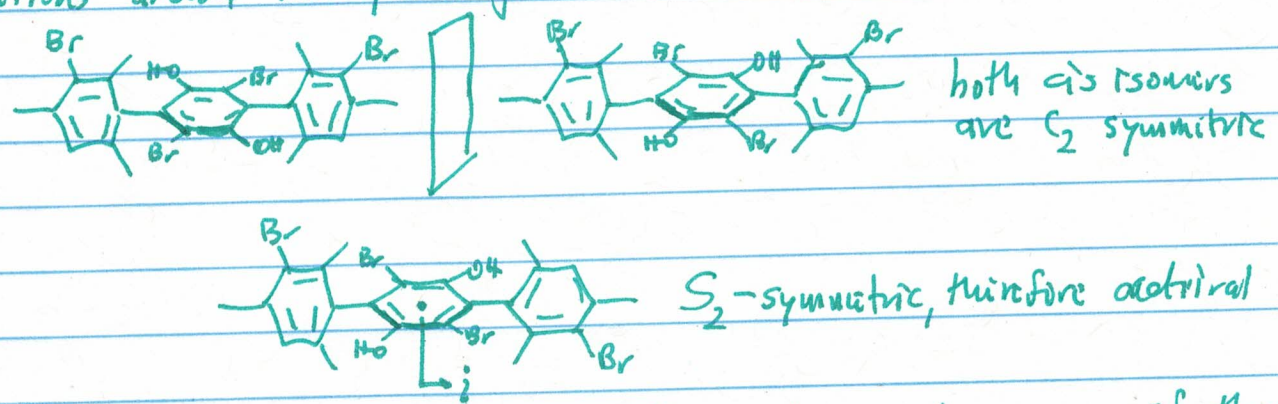
These differences in distances can translate into differences in properties. Meso-diastereomer establishes an intramolecular hydrogen bond, while the R,R and S,S enantiomers do not.

The two (or more) combined chiral elements do not have to be of the same kind:

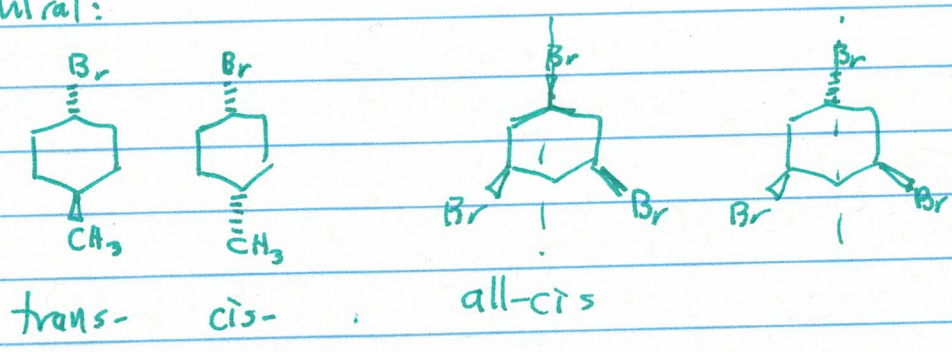


In such cases, existence of meso-forms is less common.

Torsional diastereoisomerism can be observed in molecules where rotations around multiple single bonds are restricted:



Diastereoisomers routinely occur in cyclic systems, even if they are achiral:

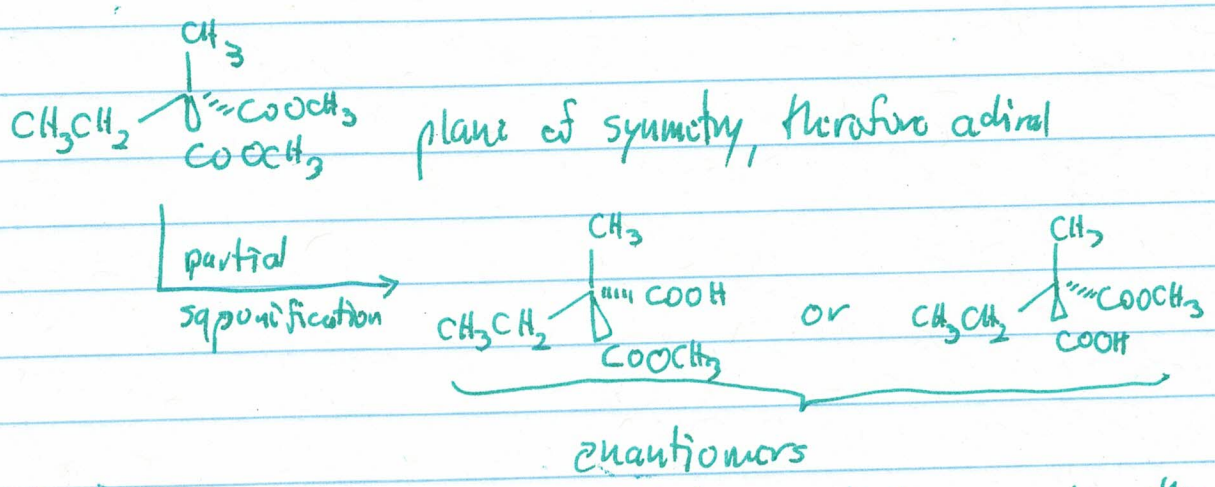


Naming of diastereomers is pretty straightforward. Each chiral element is assigned its own designator and then they are combined in the compound name.

\*

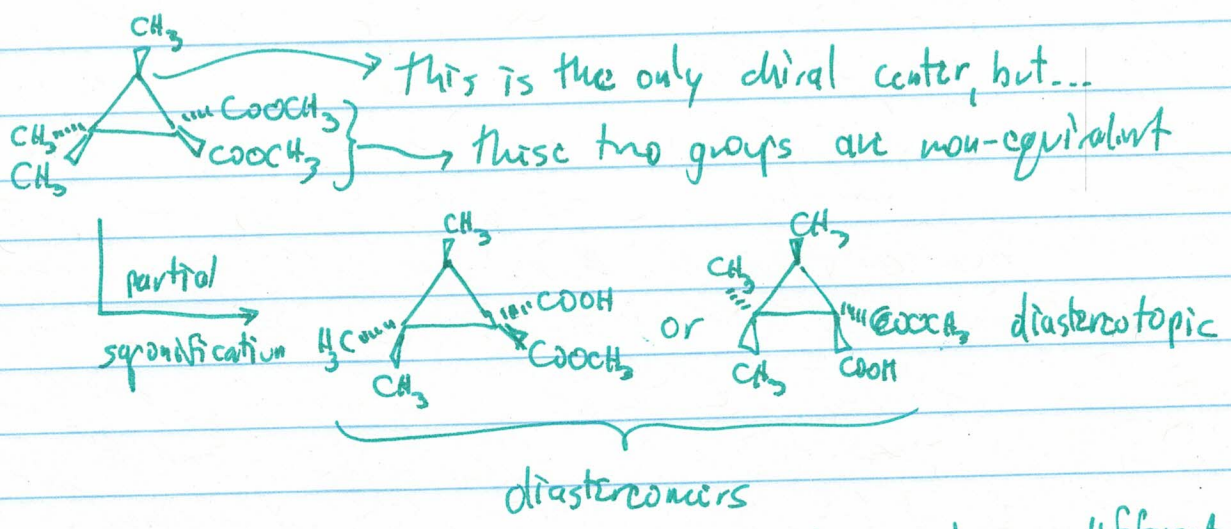
Prochirality

In achiral compounds, parts of the molecule can still find themselves in a chiral environment:

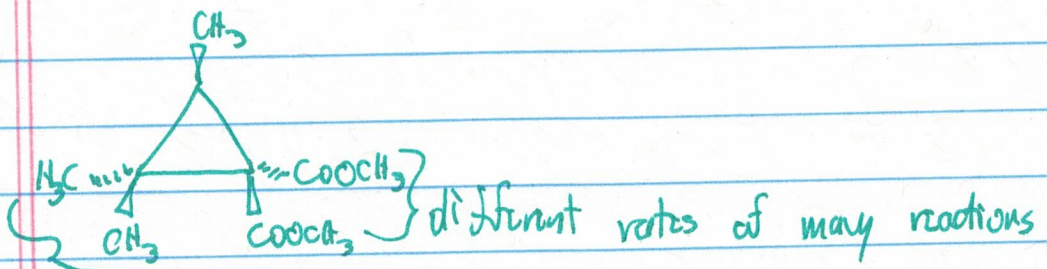


The two COOCH<sub>3</sub> groups are called enantiotopic, since the replacement of one vs. the other leads to enantiomers

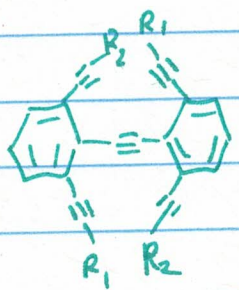
Let's consider a chiral molecule:



Diastereotopic groups feel this chemical environment as different.

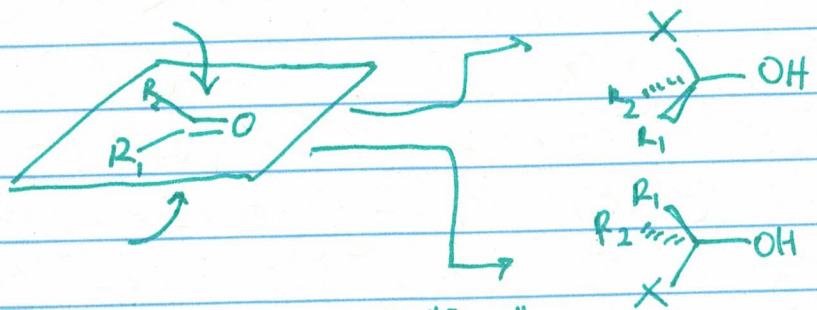


2 peaks in the NMR



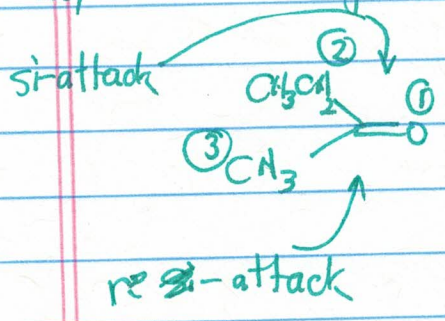
Chem Commun 2005, 2606  
 $R_1 = -SiMe_3$   
 $R_2 = -SiMe_3$  these are diastereotopic bc the rotation around C-C-C axis is restricted: allows following

Prochirality often plays an important role in chemical reactions, even those operating on achiral substrates. Additions onto the carbonyl group are a good example of that:



These two sides are called "Faces"

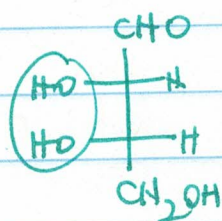
they can be assigned priorities according to CIP rules:



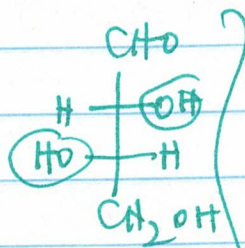
looking from the top: ② ① ③ counter-clockwise si-side

looking from the bottom: ③ ① ② clockwise re-side

\* Added note on naming diastereomers. In cases where there are only two stereocenters:



~~erythrose~~  
~~erythro~~  
erythrose  
erythro-



threose-  
threo-

this is  
used only for  
sugars today

