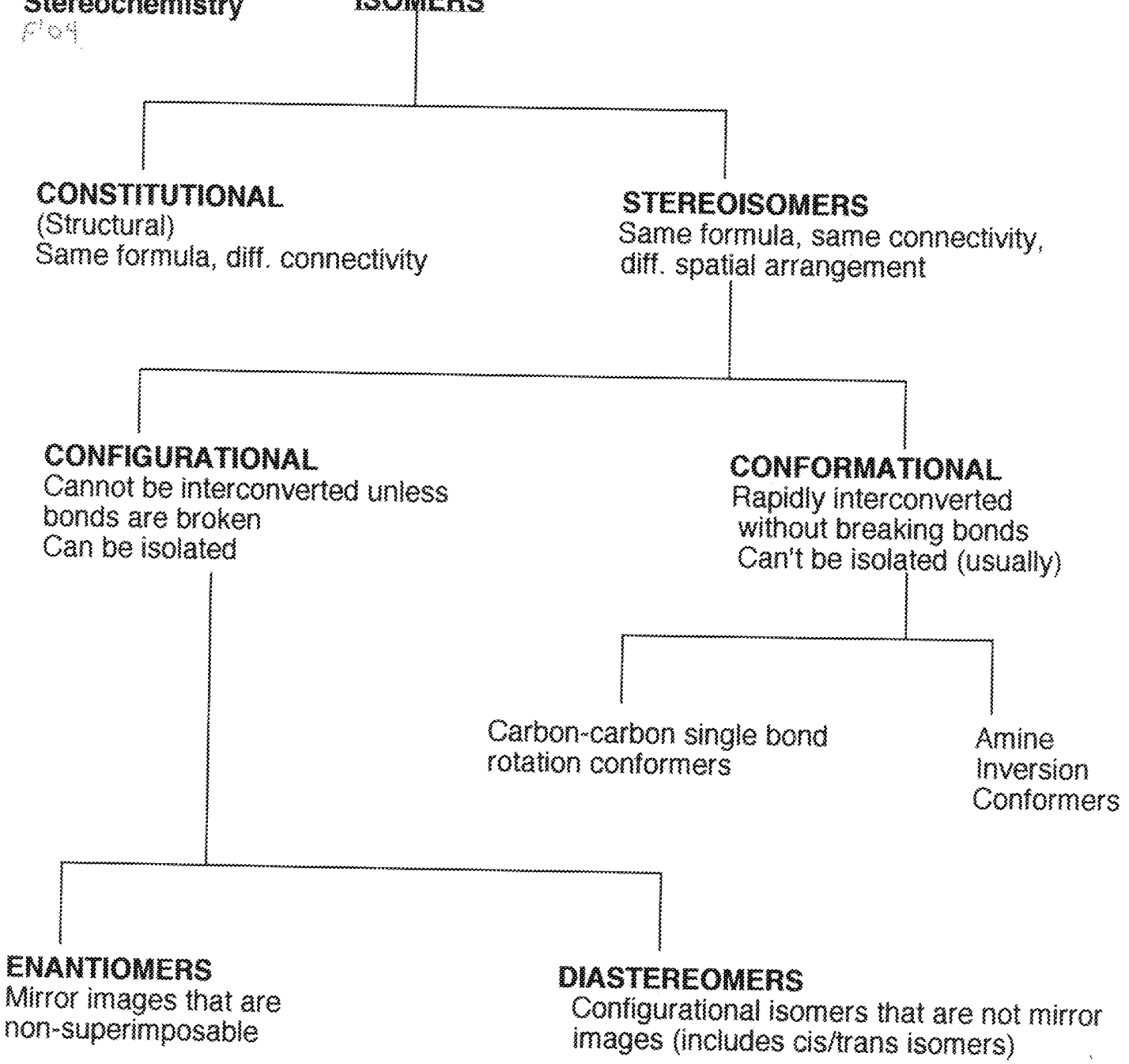
Dean

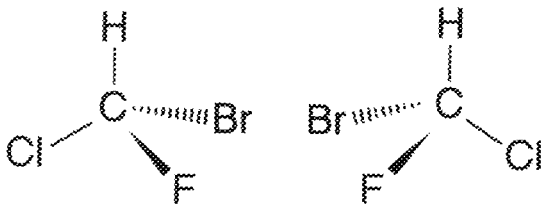
Chapter 5: Stereochemistry

F'09



Identifying chiral centers:

1.



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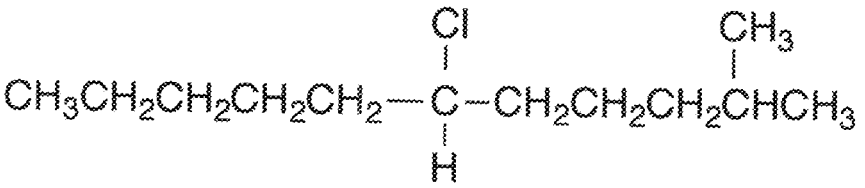

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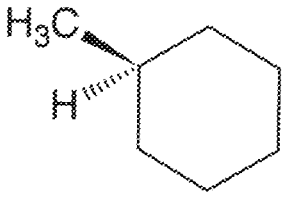

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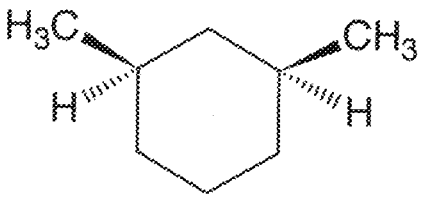
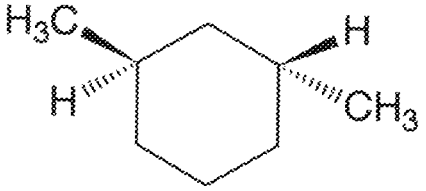


5.



Assigning R/S : (Cahn/Ingold/Prelog Conventions)

1. Assign priorities (1,2,3,4) to the four groups attached to the stereocenter based on atomic number (highest atomic #=1, lowest atomic #=4). In the case of isotopes, the isotope of greater mass gets priority.

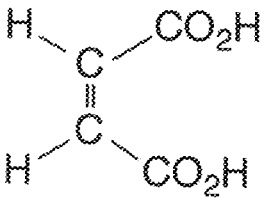
2. In the case of identical atoms attached to the stereocenter, examine the next set of atoms. Arrange atoms within each set in order of highest to lowest priority. Compare the sets and assign priority at the first point of difference.

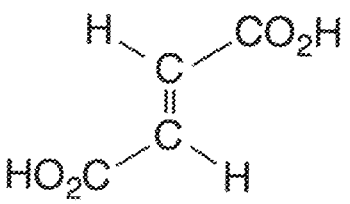
3. For groups containing double or triple bonds, the atoms of the multiple bond are duplicated or triplicated before assigning priority.

4. After assigning priorities, rotate the structure so that the lowest priority group (4) is directed away from the viewer. Draw an arrow from 1 to 2 to 3. If the arrow is clockwise, the assignment is R. If the arrow is counter clockwise, the assignment is S.

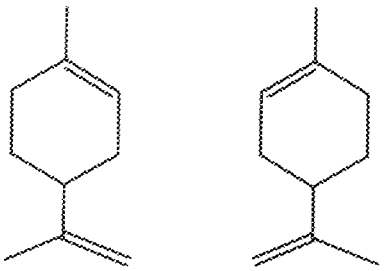
Properties of Stereoisomers

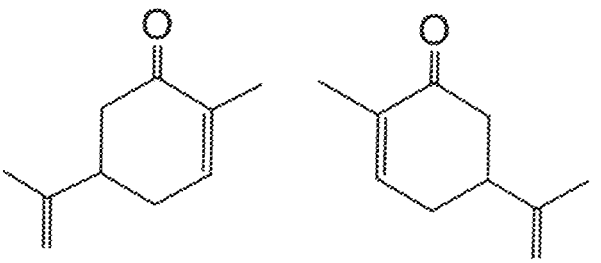
Diastereomers: different physical properties, similar chemical properties





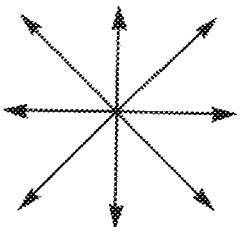
Enantiomers: identical physical and chemical properties except when interacting with another chiral agent
examples: different solubilities in chiral solvents
different reaction rates with chiral reagents





Optical Activity: interaction with plane polarized light

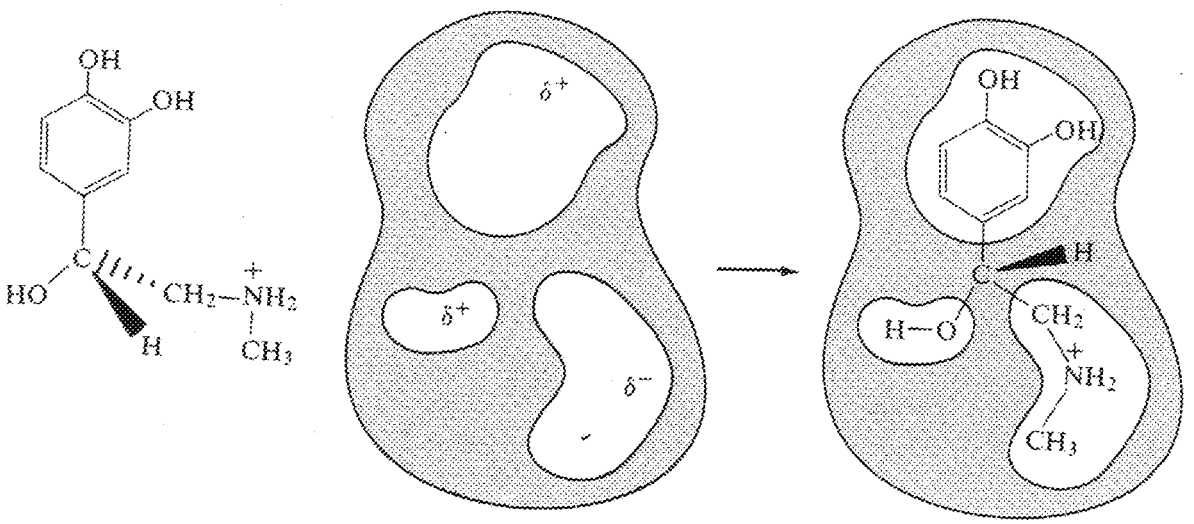
unpolarized (ordinary) light:



plane polarized light:

Enantiomers have the ability to rotate the plane of plane polarized light. Rotation is in equal amounts but opposite directions.

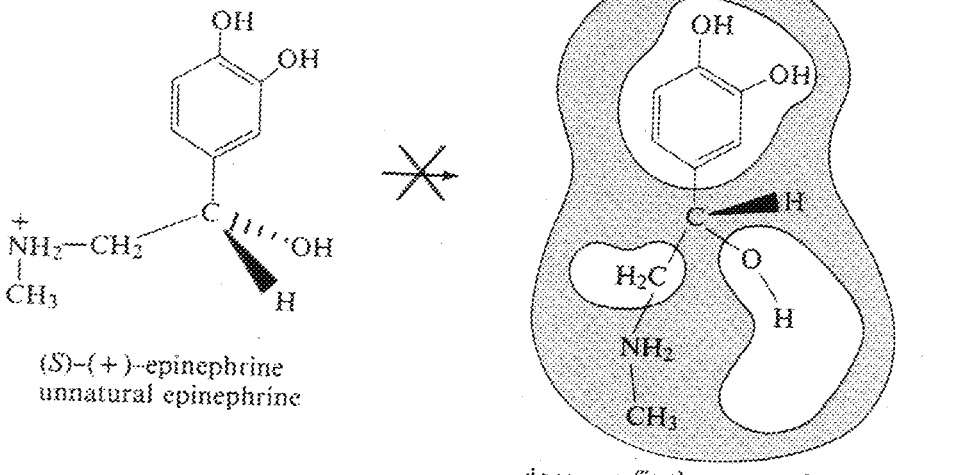
CHIRAL RECOGNITION by an ENZYME



(*R*)-(−)-epinephrine
natural epinephrine

enzyme active site

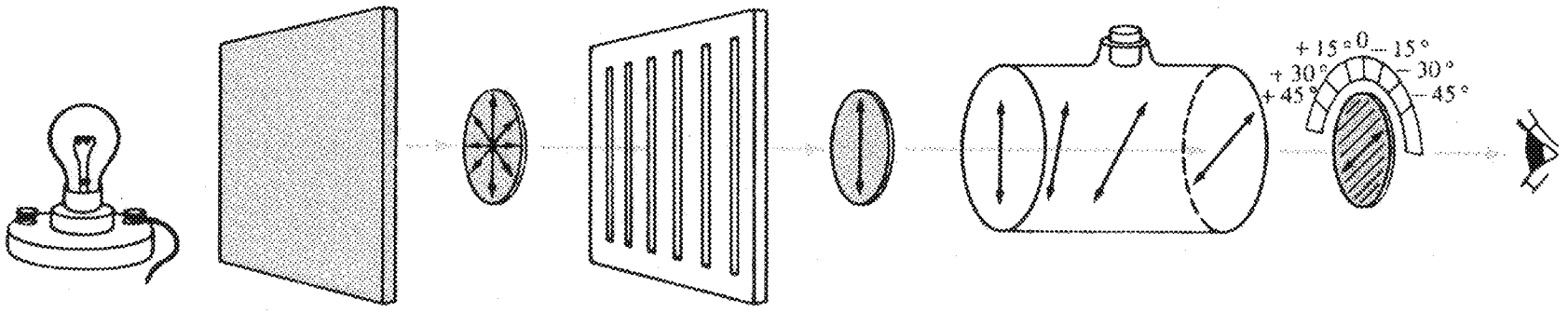
enzyme–substrate complex



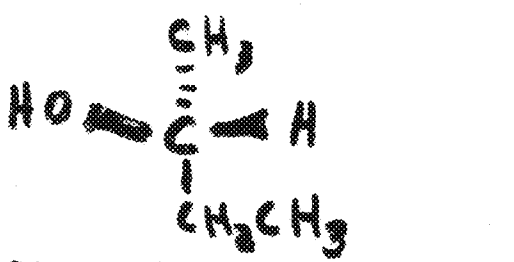
(*S*)-(+)-epinephrine
unnatural epinephrine

does not fit the enzyme's active site

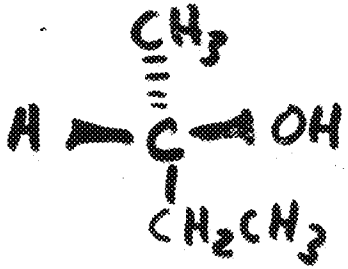
SCHEMATIC DIAGRAM of a POLARIMETER



sodium lamp | monochromator filter | polarizing filter | sample cell | analyzing filter | detector



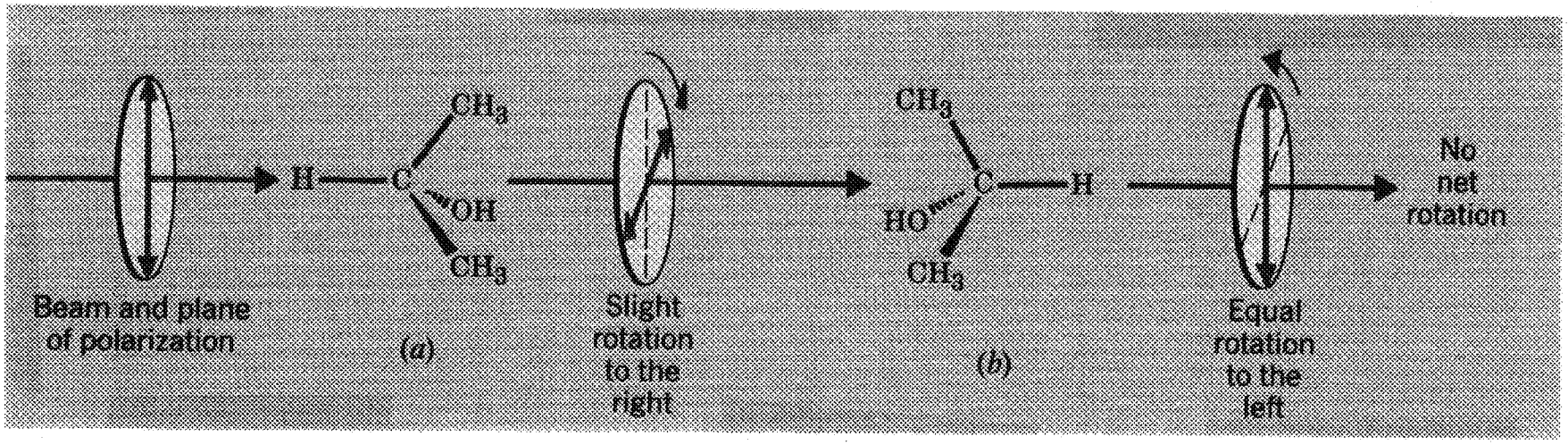
(R)-( )-2-butanol



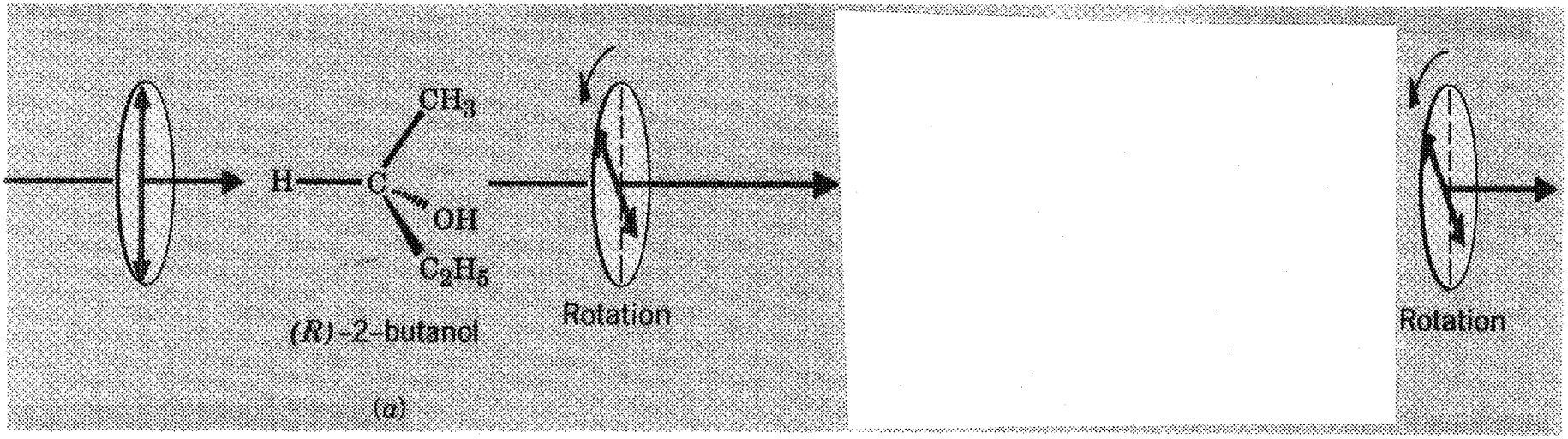
(S)-( )-2-butanol

specific rotation = $[\alpha]_D = \frac{\text{observed rotation}(\alpha)}{(\text{path length})(\text{conc.})}$

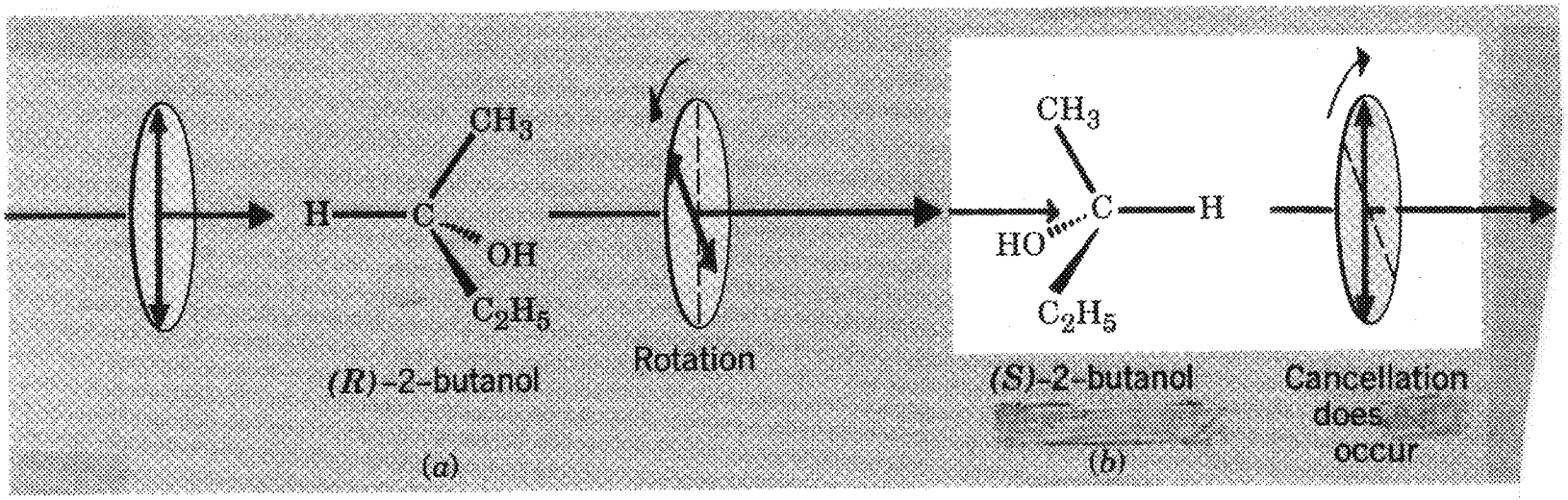
I. An achiral molecule



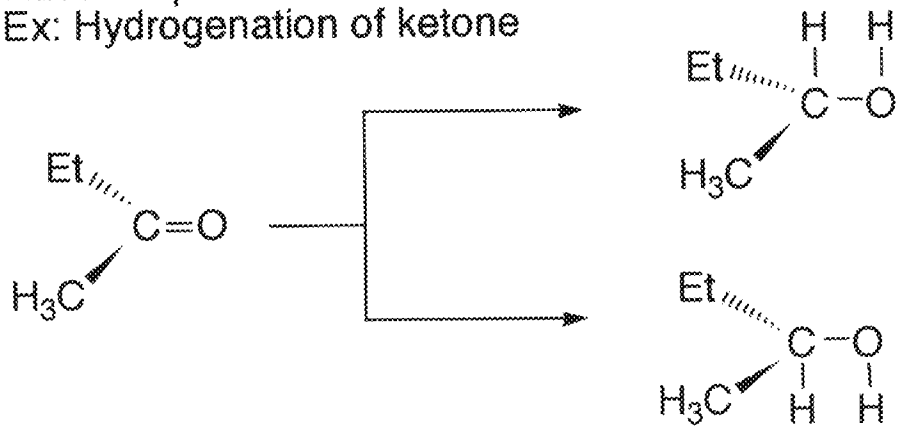
II. A chiral molecule



III. A 50/50 mixture of enantiomers (R and S)



Racemic product mixtures:
Ex: Hydrogenation of ketone



General rule:

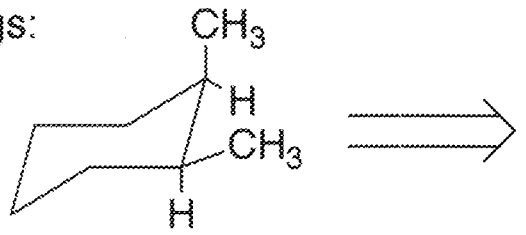
Optically inactive starting material ⟶ optically inactive product

The Chirality of Conformationally Mobile Systems

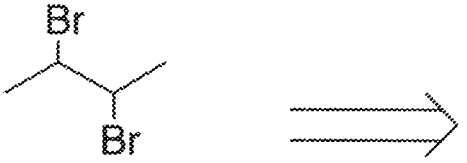
If a molecule can rotate through a symmetrical conformation, it is achiral even if one of the conformations is chiral (has no plane of symmetry).

When determining chirality in systems that exist as rapidly interconverting conformers, look for planes of symmetry in the most symmetrical representation of the molecule.

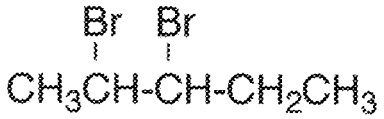
rings:



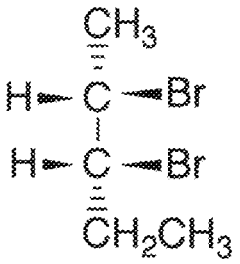
acyclic:

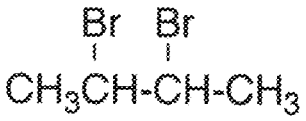


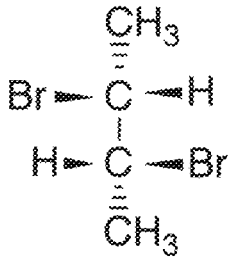
Molecules with More than One Stereocenter



Possible # of stereoisomers = 2^n
n = # of stereocenters

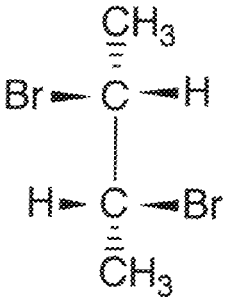






Meso compound:

Naming compounds with more than one stereocenter:



FISCHER PROJECTIONS - Analyzing 3D molecules on a flat surface

1. Main carbon chain is vertical.

2. Vertical lines represent bonds behind plane (like dashes) or in plane.

3. Horizontal lines represent bonds in front of plane (like wedges).

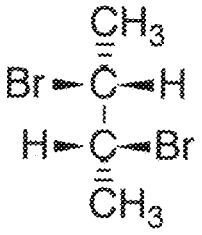
4. Intersections represent chiral carbon atoms.

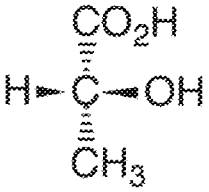
5. Most oxidized group is usually placed at the top.

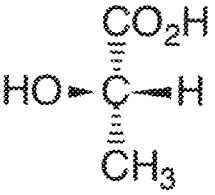
6. Fischer projections must not be removed from the plane of the paper. (They cannot be picked up and flipped over!)

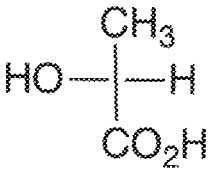
7. Projections may be rotated in two ways:
   1) The whole projection may be rotated by 180° ONLY.
   2) One group attached to a chiral carbon may be held steady and the other three groups may be rotated clockwise or counterclockwise.

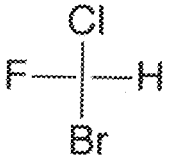
Fischer Examples

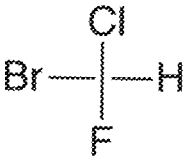


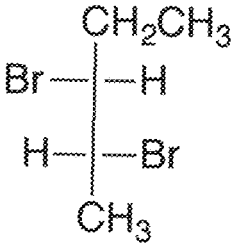


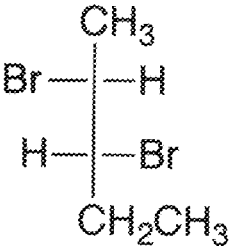


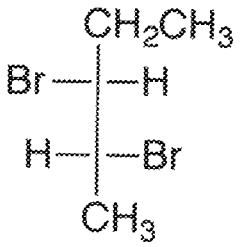


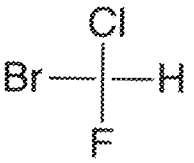






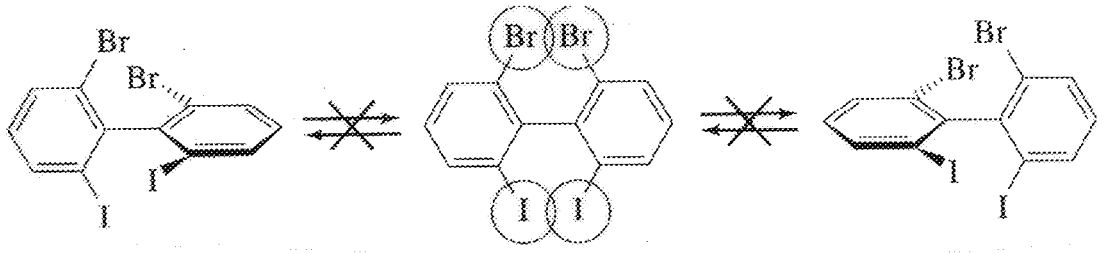




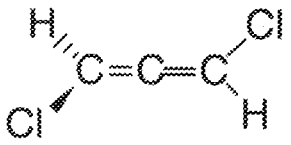


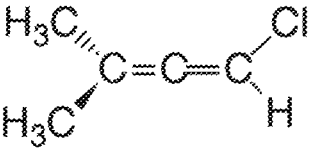
Chrial Compounds Without Chiral Atoms

1. Molecules that are "locked" into asymmetric conformations:



2. Substituted allenes:





Absolute vs Relative Configuration