So far we have built upon our understanding of the questions I and II, which deal with the number of possible stereoisomers of 2,3-dibromobutane and 2,3-dibromopentane. And, have expanded this understanding to be able to predict the products of the addition of bromine of cis- vs trans-2-butene and cis- vs trans-2-pentene (next page).

[I] Draw below all possible stereoisomers of 2,3-dibromobutane.

a) How many are there? 3
b) Indicate the absolute configuration at each chiral center \((R,S)\). **See below**
c) Indicate the relationship between the molecules (e.g. enantiomer or diastereomers). **See below**

![Diagrams](image1.png)

**Note:**
- \((R,R)\) \((S,S)\) are enantiomers
- \((S,R)\) \((S,S)\) are the same because of a meso plane
- \((R,R)\) \((S,S)\) are diastereomers of the \((S,R)\) isomer

[II] Draw below all possible stereoisomers of 2,3-dibromopentane.

a) How many are there? 4
b) Indicate the absolute configuration at each chiral center \((R,S)\). **see below**
c) Indicate the relationship between the molecules (e.g. enantiomer or diastereomers). **see below**

![Diagrams](image2.png)

**Note:**
- \((R,R)\) \((S,S)\) are enantiomers
- \((S,R)\) \((R,S)\) are enantiomers
- \((R,R)\) \((S,S)\) are diastereomers of the \((S,R)\) \((R,S)\) isomers
Draw the products of the addition of bromine across cis- vs trans-2-butene and cis- vs trans-2-pentene.

a) How many stereoisomers are there?
b) Indicate the absolute configuration at each chiral center (R,S).
c) Is the product chiral or achiral. See below

We see for the case of 2-pentene there is no chance of a meso-plane. So, both reactions produce a racemic mixture of a given diastereomer.
This meso plane can also be broken from the anti-addition of two different groups as in the anti-addition of a Br and OR group in the solvent participation addition of bromine in water (R = H) or alcoholic solvent across cis- vs trans-2-butene.

\[
\begin{align*}
\text{Br}_2 & \quad \text{ROH} \quad \rightarrow \quad (R)_{\text{Br}} \quad \text{and} \quad (S)_{\text{Br}} \quad \text{OR} \quad \equiv \quad \text{Br} \quad \text{OR} \\
\text{Br}_2 & \quad \text{ROH} \quad \rightarrow \quad (R)_{\text{Br}} \quad \text{OR} \quad \equiv \quad (R,S)_{\text{Br}} \quad \text{OR} \quad \text{(S,S); chiral so two enantiomers are formed as a racemic mixture}
\end{align*}
\]

A similar result is found for the oxy-mercuration of cis- vs trans-2-butene in the solvent participation solvents like in water (R = H) or alcoholic solvent. This reaction we have seen used in combination with the NaBH₄ reduction to give the net addition of ROH across the double bond or with NaBH₄/O₂ to give the net unselective addition of RO/OR across the double bond.

\[
\begin{align*}
\text{Hg(OAc)}_2 & \quad \text{ROH} \quad \rightarrow \quad (R)_{\text{HgOAc}} \quad \text{and} \quad (S)_{\text{HgOAc}} \quad \text{OR} \quad \equiv \quad \text{HgOAc} \quad \text{OR} \\
\text{Hg(OAc)}_2 & \quad \text{ROH} \quad \rightarrow \quad (R)_{\text{HgOAc}} \quad \text{OR} \quad \equiv \quad (R,S)_{\text{HgOAc}} \quad \text{OR} \quad \text{(S,S); chiral so two enantiomers are formed as a racemic mixture}
\end{align*}
\]
Thus in the above oxy-mercuration case when \( R = H \), the net two-step reaction gives an unselective addition of two hydroxyl-groups across either cis- or trans-olefins.

**Net unselective dihydroxylation:**

\[
\begin{align*}
\text{Net unselective dihydroxylation:} \\
\text{Net anti-selective dihydroxylation:}
\end{align*}
\]

Like the addition of \( \text{Br}_2 \) across a double bond we know of two methods for the stereoselective addition of two hydroxyl-groups across either cis- or trans-olefins.

These consist of the epoxidation/acid catalyzed ring opening:

**Net anti-selective dihydroxylation:**

\[
\begin{align*}
\text{Net anti-selective dihydroxylation:} \\
\text{Net syn-selective dihydroxylation:}
\end{align*}
\]

And, the osmium tetroxide catalyzed cis-dihydroxylation of olefins:

**Net syn-selective dihydroxylation:**
This chemistry links up nicely with some nice stereoselective alkyne to alkene reduction chemistry to make either cis- or trans-olefins:

Cis-selective hydrogenation vs trans-selective Birch reduction of alkynes:

\[
\text{cis} \quad \text{H}_2 \quad \text{Lindlar's cat} \quad \rightarrow \quad \text{K in NH}_3
\]