In contrast to the result of the previous segment, from E-2-butene two enantiomeric oxiranes are formed by electrophilic addition of peracids to the two enantiomorphous faces of the olefin; hydrolysis of each of these oxiranes by each of two inversion routes leads only to achiral (R,S) 2,3-butanediol:

\[
\begin{align*}
\text{E-2-butene and peracids yield only chiral oxiranes and,} \\
\text{in consequence, only achiral (R,S) 2,3-butanediol}
\end{align*}
\]

It should be noted again that the stereochemical outcome of (overall) trans hydroxyl group additions, achieved through the intermediacy of oxiranes, is precisely opposite to that for the cis hydroxylation route mediated by osmium tetroxide or
potassium permanganate and previously summarized in Segment 12.04. In those cases, $Z$-2-butene gave achiral (R,S) 2,3-butanediol and $E$-2-butene yielded chiral (R,R and S,S) 2,3-butanediol.

The theme of enantioselective reaction, first outlined in schematic form in Segment 12.06, again comes up here. We saw previously that — with the necessary involvement of a chiral controlling reagent — enantioselective osmium-tetroxide-mediated cis hydroxyl addition, differentiating the enantiomorphous faces of the olefin, could be accomplished on $E$-2-butene, to produce an excess of either (R,R) or (S,S) 2,3-butanediol. Under appropriate reaction conditions, again using a chiral controller, chemical differentiation can be made between the enantiomorphous faces of $E$-2-butene, to obtain an excess of either the (R,R) oxirane or its (S,S) enantiomer, depending on the chirality of the controller.

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