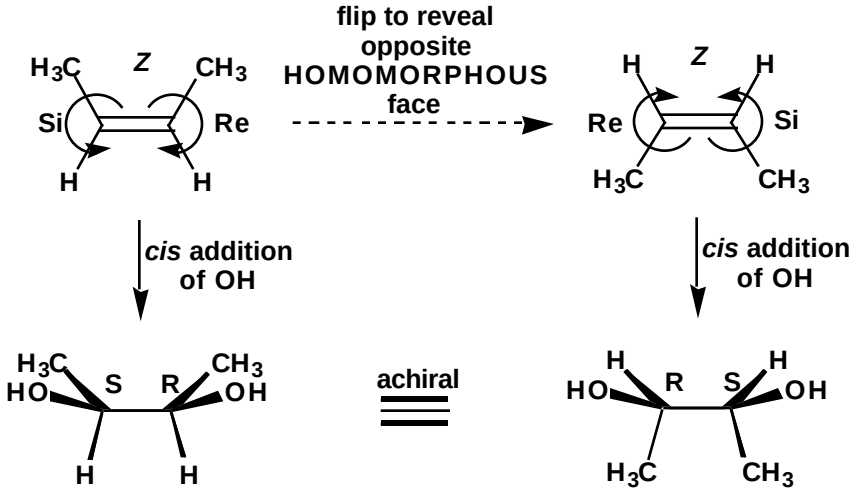
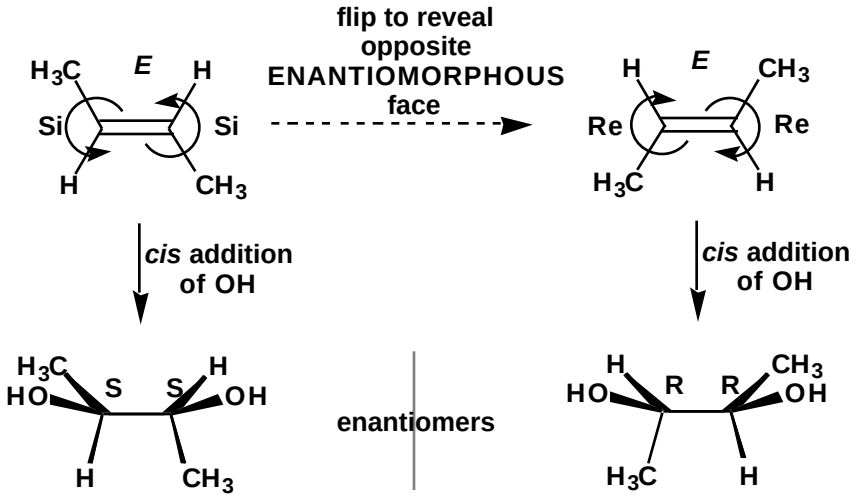
Text Related to Segment 12.05 ©2002 Claude E. Wintner

With respect to the *cis*-stereospecific reaction we just have introduced, there is an instructive point to be made — one which recalls our discussion of two-dimensional chirality. The two faces of *Z*-2-butene are homomorphous and cannot be distinguished, a result of the fact that each face possesses a Re and a Si center, and each with identical substitution. Therefore, addition of two hydroxyl groups on the same face of *Z*-2-butene, one at each center — that is, *cis* hydroxyl addition, as with osmium tetroxide — must give the same result for either face: achiral (R,S) 2,3-butanediol.



In contrast, the two faces of *E*-2-butene are enantiomorphous, one being Re, Re and the other Si, Si. Hence, *cis* hydroxyl addition to *E*-2-butene must result in enantiomers — the racemic form of chiral (R,R and S,S) 2,3-butanediol:



The difference in stereochemical result between the interaction of the osmium tetroxide reagent with (either) Re, Si face of *Z*-2-butene on the one hand, and with the Re, Re face (or the Si, Si face) of *E*-2-butene on the other, is the result of the diastereomorphous difference between these two interactions. In the one case the osmium "sees" a "left hand" and a "right hand" together. In the other the osmium "sees" two "right hands" (or two "left hands") together. The result is diastereomorphism in the products, that is, the diastereoisomeric products achiral or chiral 2,3-butanediol. Note that a chiral reagent is *not* a necessary condition for the recognition of the Re, Si versus Re, Re (or Si, Si) stereochemical difference. On the other hand, a chiral reagent *is* required for the recognition of the (enantiomorphous) Re, Re versus Si, Si stereochemical difference. This point will be elaborated in the next segment.

An analysis parallel to the one above leads to the conclusion that *trans* addition of two hydroxyl groups to *Z*-2-butene should lead to *racemic* 2,3-butanediol and *trans* addition of two hydroxyl groups to *E*-2-butene should yield *achiral* 2,3-butanediol. Soon we shall meet such *trans* additions; indeed, hydrolysis of the oxiranes (epoxides) obtained from peracid oxidation of olefins — an

alternative synthetic route to 1,2-diols — will turn out to represent just such an overall process.

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