

# Summary

- Orbital alignment requirements in the [S<sub>N</sub>2] and [E2] pathways have stereochemical consequences.
- The  $\sigma \rightarrow \sigma^*$  sigma-type interaction of the [S<sub>N</sub>2] pathway results in inversion of configuration at carbon.
- In the [E2] pathway, the C<sub>β</sub>-H bond and the C<sub>α</sub>-X bonds break simultaneously; these bonds must be parallel to one another to allow the orbitals involved to be properly aligned.
  - ⇒ Acyclic compounds can orient the two bonds in two ways: synperiplanar (eclipsing at a 0° dihedral angle) or antiperiplanar (staggering at a 180° angle). The antiperiplanar conformation is generally lower in energy and the reaction usually proceeds through this conformation.
  - ⇒ In cyclic compounds, there are much greater restrictions on conformational flexibility. In six-membered rings, the antiperiplanar requirement for [E2] elimination is satisfied when both the leaving group and the adjacent H atom are axial.
- In principle, any lone pair can act as either a base or a nucleophile toward C(sp<sup>3</sup>)-X. Thus, it is sometimes difficult to decide if a reaction will follow the [E2] or [S<sub>N</sub>2] pathway. The competition between substitution vs. elimination depends on two factors: (1) the nucleophilicity vs. basicity of the lone-pair and (2) the identity of the alkyl halide substrate (1°, 2°, 3°). The table summarizes the behavior.

## *Factors determining substitution vs. elimination under basic conditions*

Alkyl halide	good nucleophile poor base	good nucleophile good base	poor nucleophile good base
1°	S <sub>N</sub> 2	S <sub>N</sub> 2	E2
2°	S <sub>N</sub> 2	S <sub>N</sub> 2 < E2	E2
3°	E2 or no reaction	E2	E2

Examples of good nucleophiles and poor bases: Br<sup>-</sup>, I<sup>-</sup>, RS<sup>-</sup>

Examples of good nucleophiles and good bases: RO<sup>-</sup>, R<sub>3</sub>N, RC≡C<sup>-</sup>

Example of poor nucleophile and good base: *t*-BuO<sup>-</sup>