Angle Strain
Chair + Boat forms of cyclohexane
Cis + trans
Axial vs equatorial

\[ \begin{align*}
\text{Cyclopropane} & \quad \text{highly strained} \\
\text{Cyclobutane} & \quad \text{not planar!}
\end{align*} \]

Cyclopentane
Cyclohexane

- Rings with 7-11 carbons have a very small amount of strain; past 11 carbons, rings again have no strain

Cyclohexane

Axial substituents
equatorial substituents

Vicinal - refers to neighboring positions
Geminal - refers to two substituents on the same position
Vicinal dihalide

\[ \begin{align*}
\text{cis-} & \quad \text{both pointed the same way} \\
\text{trans} & \quad \text{5, 6, 1} \\
\text{cis-} & \quad \text{5, 6, 1} \\
\text{trans} & \quad \text{4, 3, 2}
\end{align*} \]
For vicinal cis-substituted cyclohexane rings, one substituent is always axial, the other equatorial ring flip—an inversion of a cyclohexane ring in which axial substituents become equatorial and vice versa.

This is an improper ring flip; the axial + equatorial positions were exchanged, producing a mirror image molecule.

This is a proper ring flip because the relative geometry (up vs down) is maintained.

Also correct lower energy

trans-substituents pointed opposite ways

For vicinal trans-substituted cyclohexane rings, both substituents are either axial or equatorial.
Di axial steric strain — two axial substituents are close enough together to experience steric hindrance.

Therefore, when possible, the most sterically strained substituent will adopt the equatorial position.

Every bond in a chain structure has a staggered — not eclipsed — geometry.

(crest of the ring)