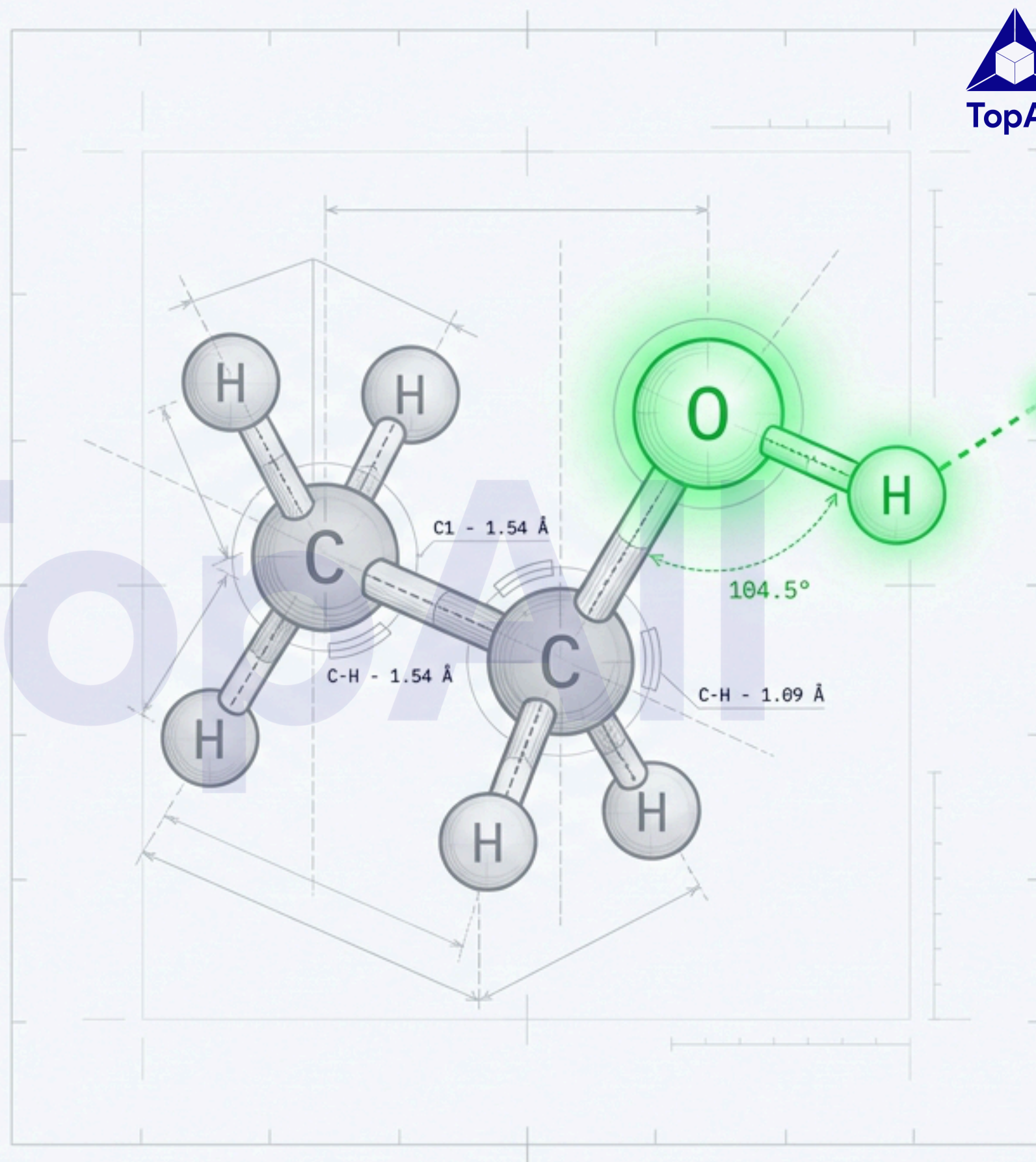


Hydrogen Bonding Controls Properties

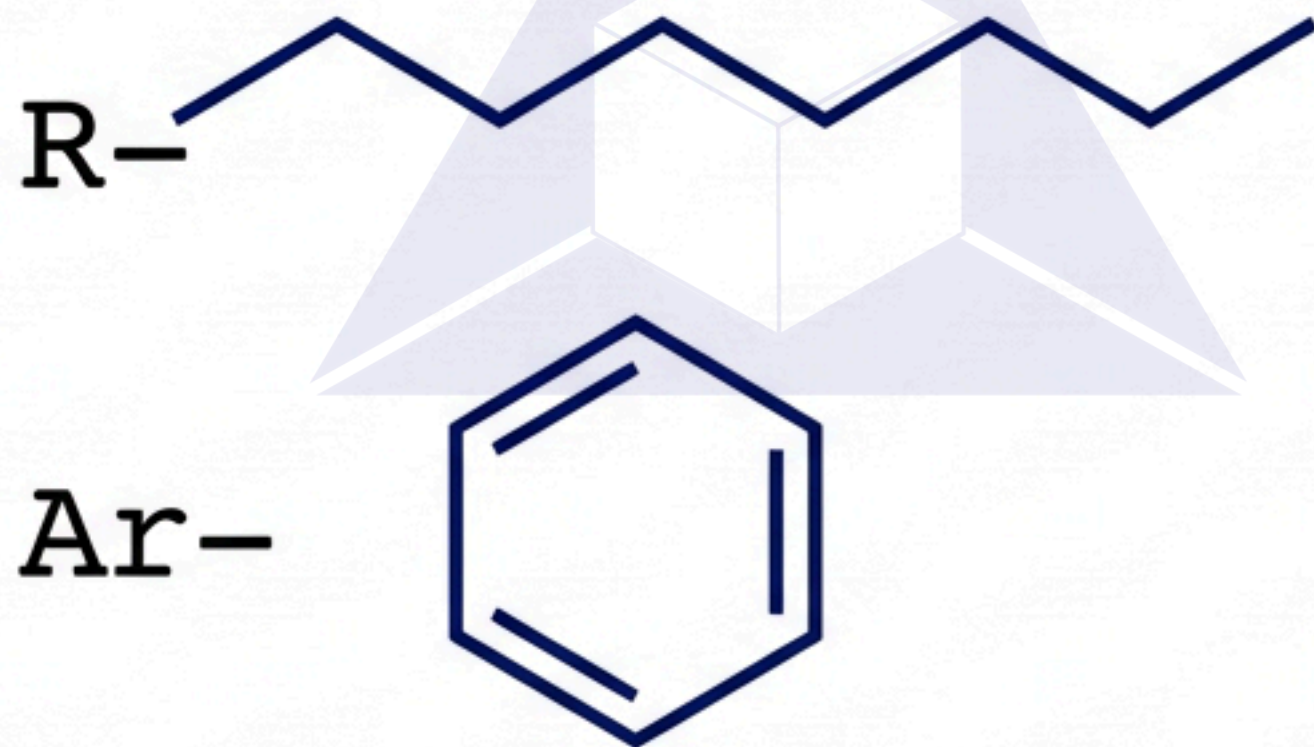
Physical Properties of Alcohols and Phenols

Structure Dictates Function



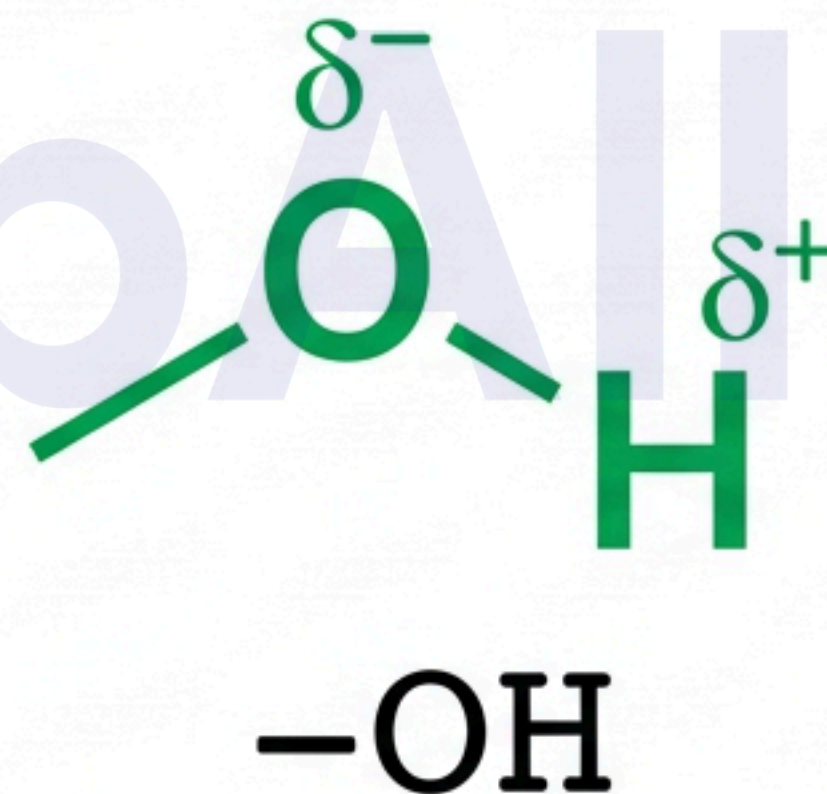
The Hydrophobic Tail

The Alkyl (aliphatic) or Aryl (aromatic) group. Non-polar, resists water, interacts via weak van der Waals forces.



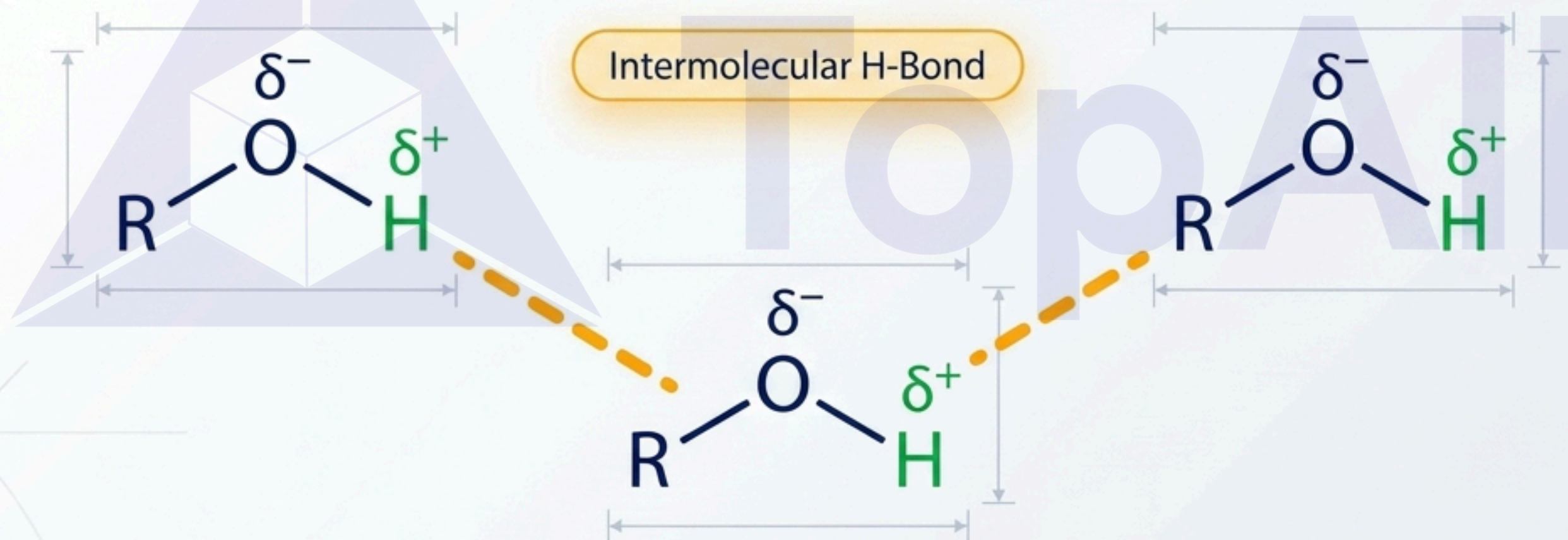
The Hydrophilic Head

The Hydroxyl group. Highly polar, water-loving, dictates primary chemical and physical interactions.



Intermolecular Hydrogen Bonding

The polarity of the -OH group allows molecules to magnetically link together. This creates a strong network that requires significant energy to break.



The Boiling Point Anomaly

Alcohols require significantly more thermal energy to vaporize than hydrocarbons or ethers of comparable molecular mass due to their hydrogen-bonded networks.

Alkane

Propane | Mass: ~44
Formula: $\text{CH}_3\text{CH}_2\text{CH}_3$

Force:
Weak van der Waals

Force:
Weak van der Waals



BP: Lowest

Ether

Methoxymethane
Formula: CH_3OCH_3

Force:
Dipole-dipole

Force:
Dipole-dipole



BP: Intermediate

Alcohol

Ethanol | Mass: ~46
Formula: $\text{CH}_3\text{CH}_2\text{OH}$

Force:
Strong H-Bonding

Force:
Strong H-Bonding



BP: Highest (351 K)



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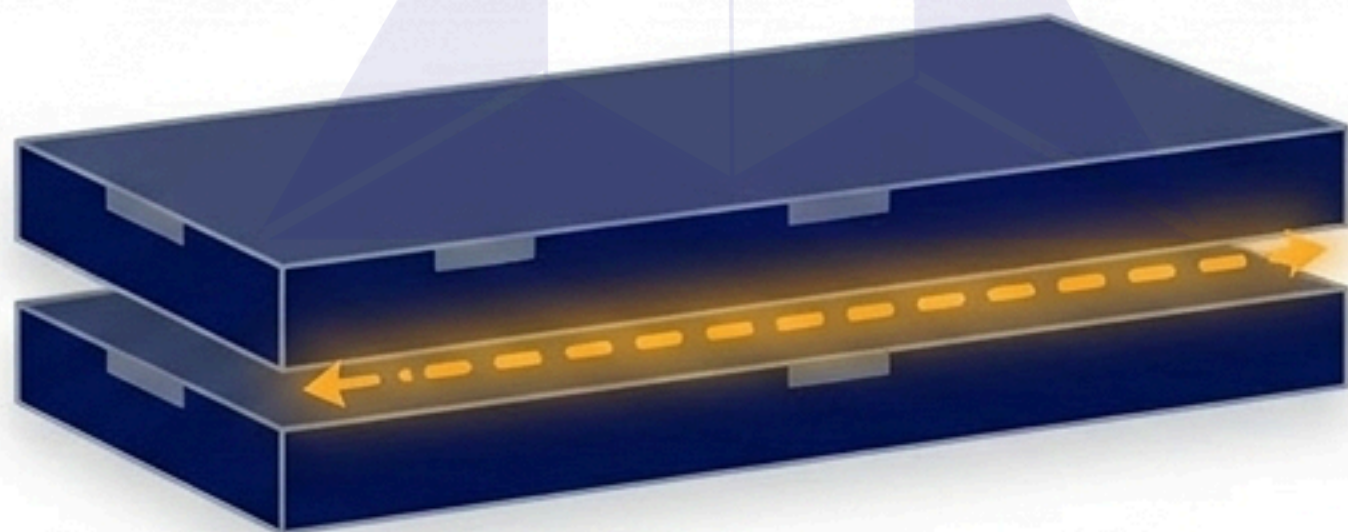


Branching Lowers the Boiling Point

As the carbon chain branches, the molecule becomes more spherical. This decreases the surface area available for van der Waals forces, lowering the boiling point.

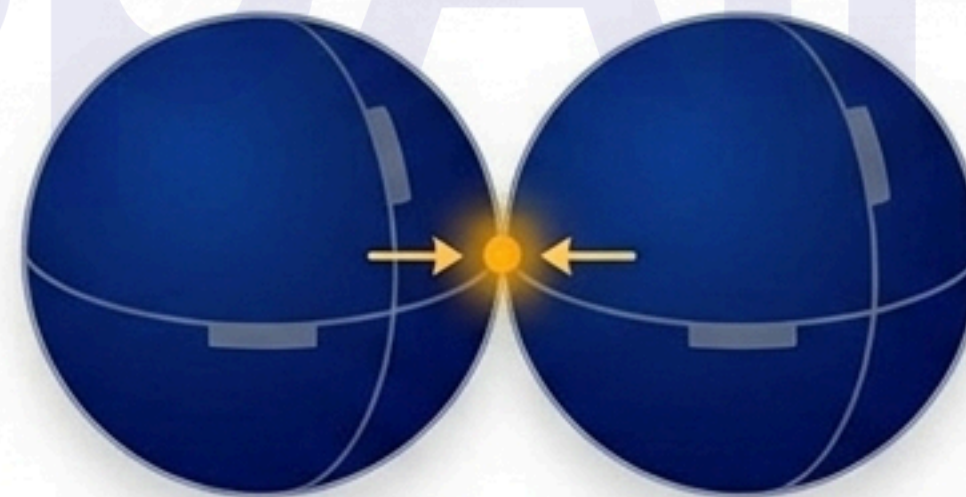
Linear = High Surface Area

Butan-1-ol ($\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{OH}$)



Branched = Low Surface Area

2-Methylpropan-2-ol

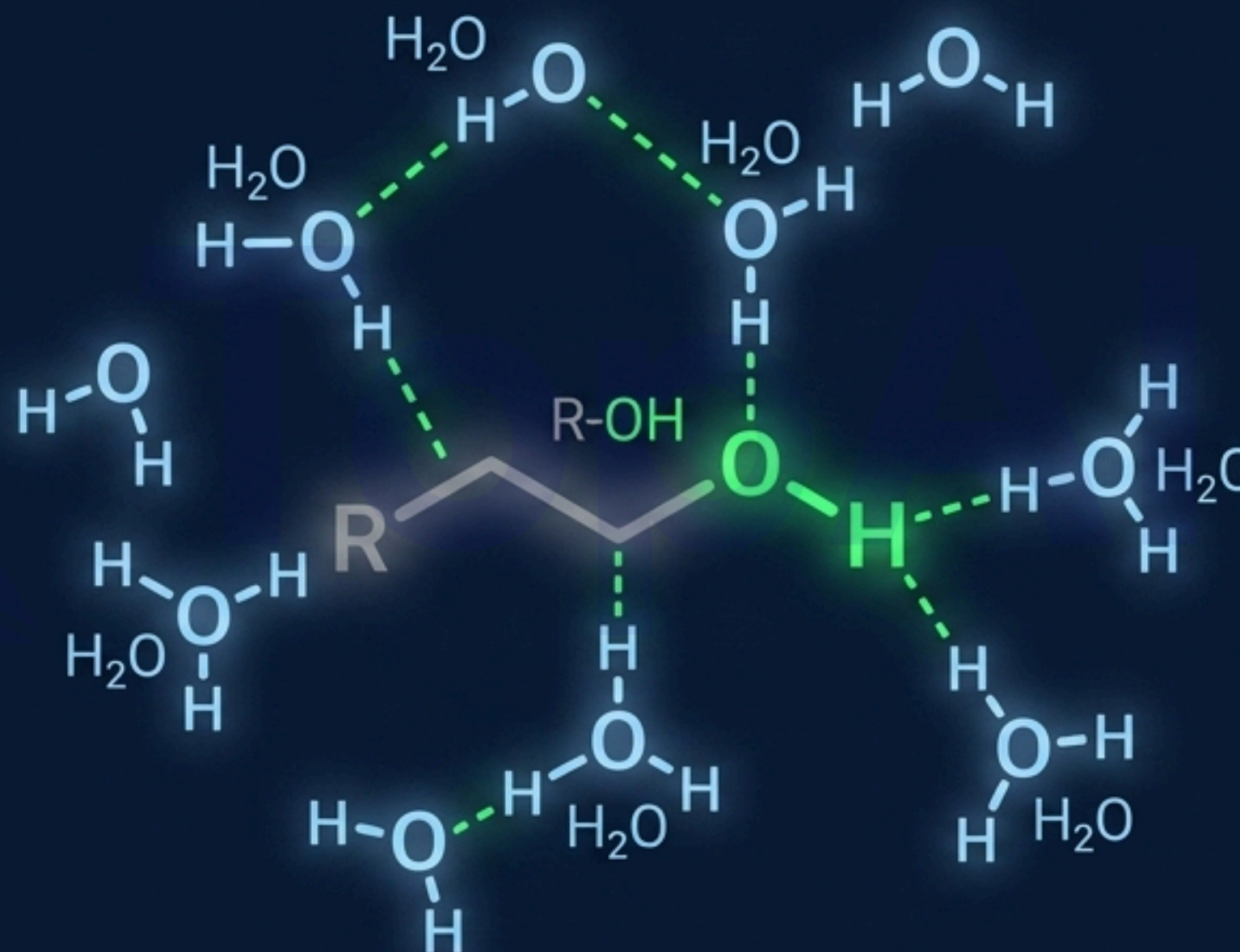


Less Surface Area → Weaker Forces → Lower BP

Solubility in Water

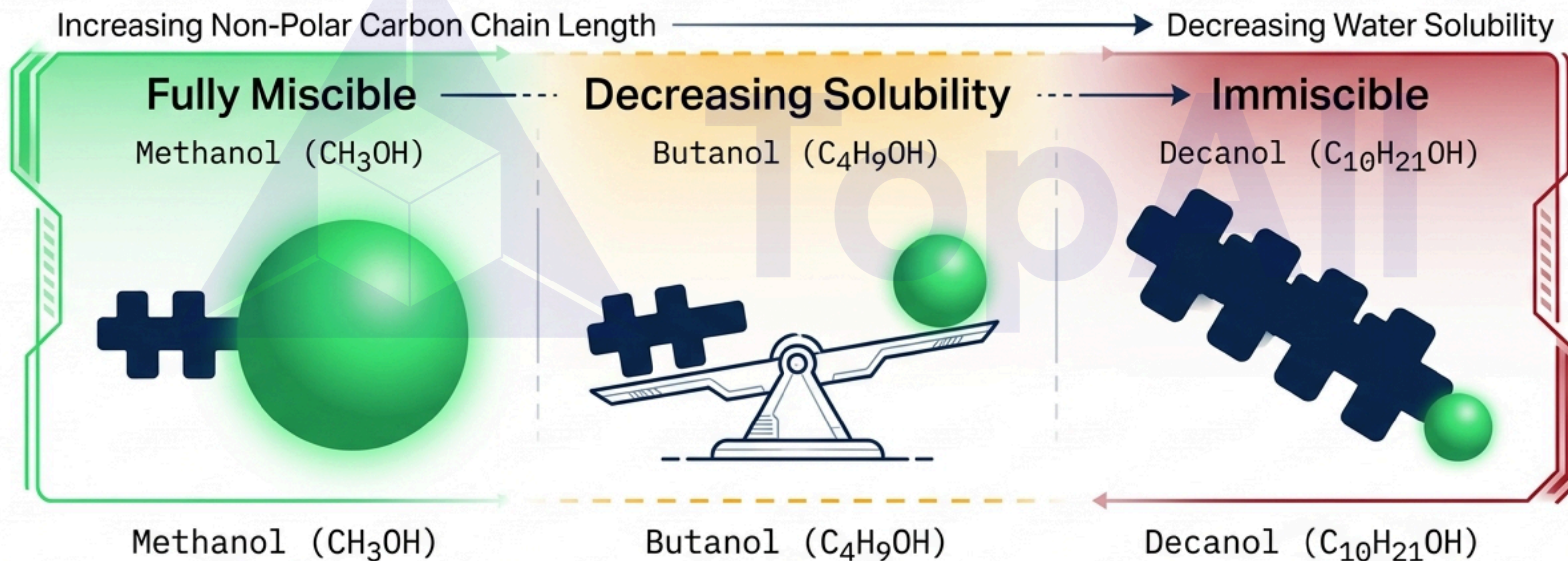
Lower molecular mass alcohols are miscible in water in all proportions.

They dissolve by integrating directly into water's own hydrogen-bonded network.



The Hydrophobic Effect

As the non-polar carbon group grows larger, it physically overwhelms the hydrophilic hydroxyl group, severely decreasing water solubility.



Key Takeaways: Structure & Function

The baseline properties are set by the Hydroxyl group, while the Carbon skeleton modulates the intensity.

Variable	Mechanism	Effect
The Hydroxyl Group ($-OH$)	Intermolecular Hydrogen Bonding	Drastically increases Boiling Point and Water Solubility .
Carbon Chain Length	Increases van der Waals forces / Hydrophobic bulk	Increases BP, Decreases Solubility.
Chain Branching	Creates spherical shape, reduces surface area	Lowers Boiling Point.

Hydrogen bonding sets the rules; the carbon skeleton bends them.



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