Course Code: SERHC2

WATER

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- Water is the most abundant substance in living systems, making up 70% or more of the weight of most organisms.
- Water has a higher melting point, boiling point, and heat of vaporization than most other common solvents
- Each hydrogen atom of a water molecule shares an electron pair with the central oxygen atom.
- H-bond between water molecules provide cohesive force to determine the state-solid, liquid, or gas.
- Water is a polar solvent. It readily dissolves most biomolecules, which are generally charged or polar compounds.
- When an amphipathic compound is mixed with water, the polar, hydrophilic region interacts favorably with the solvent and tends to dissolve, but the nonpolar, hydrophobic region tends to avoid contact with the water.
- Pure water is slightly acidic.

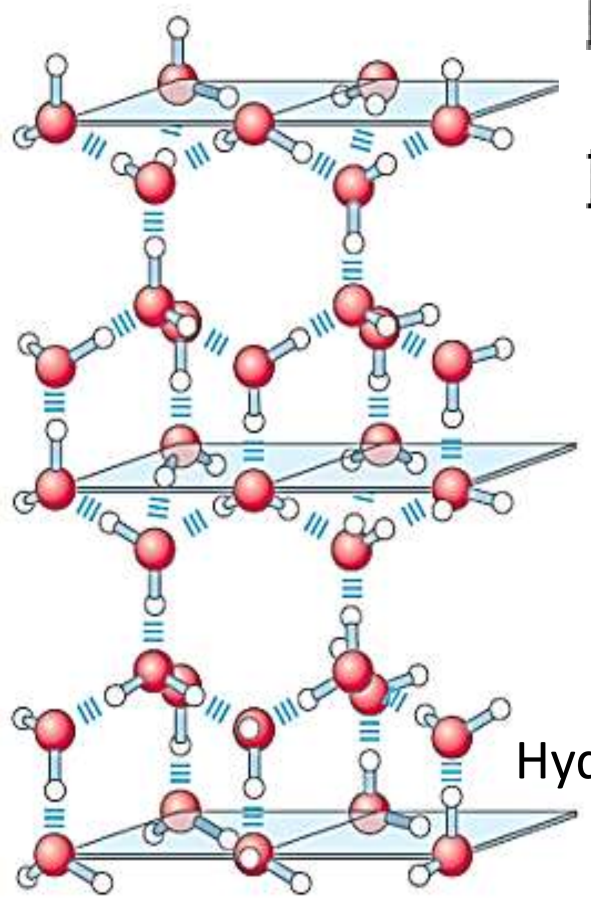
TABLE 2-1 Melting Point, Boiling Point, and Heat of Vaporization of Some Common Solvents

	Melting point (°C)	Boiling point (°C)	Heat of vaporization (J/g)*
Water	0	100	2,260
Methanol (CH_3OH)	−98	65	1,100
Ethanol (CH_3CH_2OH)	−117	78	854
Propanol ($CH_3CH_2CH_2OH$)	−127	97	687
Butanol ($CH_3(CH_2)_2CH_2OH$)	−90	117	590
Acetone (CH_3COCH_3)	−95	56	523
Hexane ($CH_3(CH_2)_4CH_3$)	−98	69	423
Benzene (C_6H_6)	6	80	394
Butane ($CH_3(CH_2)_2CH_3$)	−135	−0.5	381
Chloroform ($CHCl_3$)	−63	61	247

*The heat energy required to convert 1.0 g of a liquid at its boiling point, at atmospheric pressure, into its gaseous state at the same temperature. It is a direct measure of the energy required to overcome attractive forces between molecules in the liquid phase.

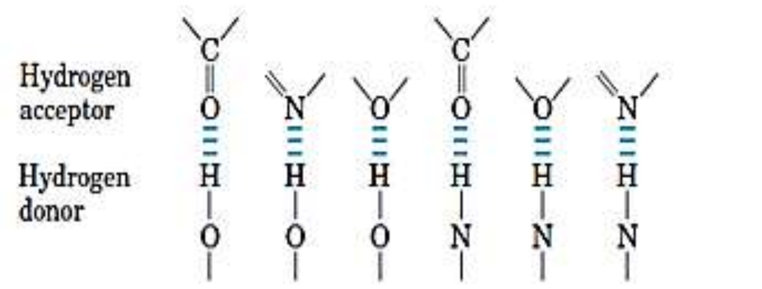
$$H_2O\ (solid) \rightarrow H_2O\ (liquid) \qquad \Delta H = +5.9\ kJ/mol$$

$$H_2O\ (liquid) \rightarrow H_2O\ (gas) \qquad \Delta H = +44.0\ kJ/mol$$



Hydrogen bonding in ice

Water Forms Hydrogen Bonds with Polar Solutes



sp3 bonding orbitals of carbon

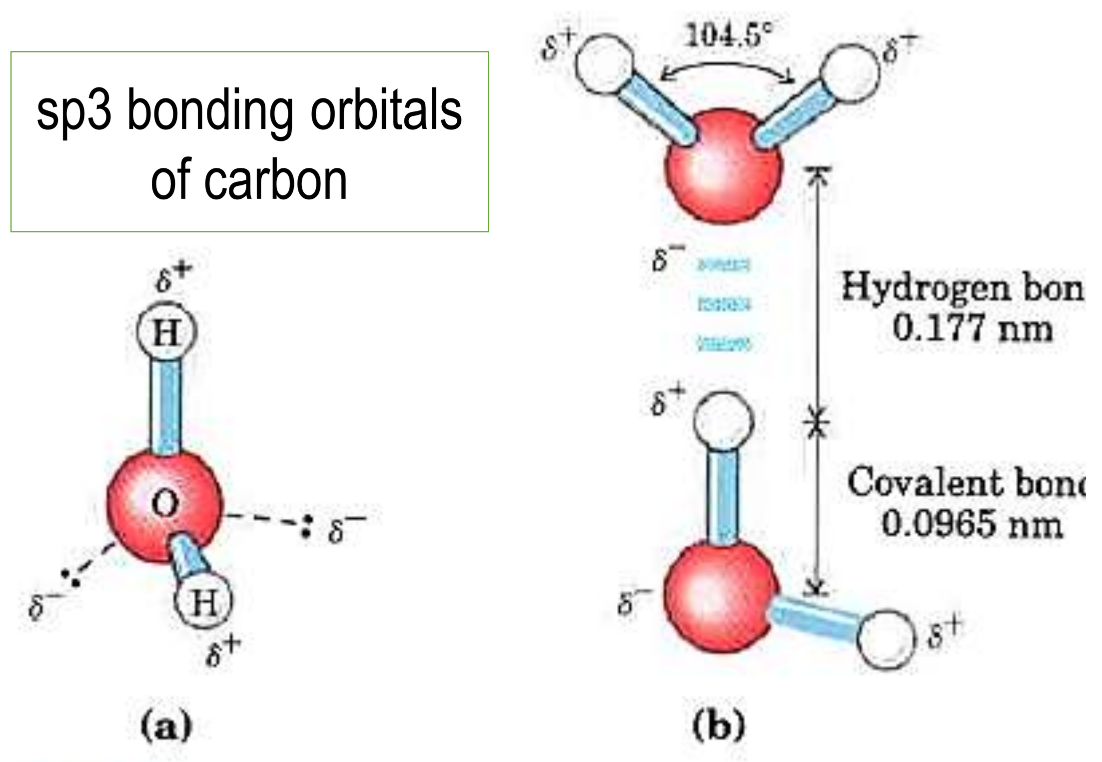
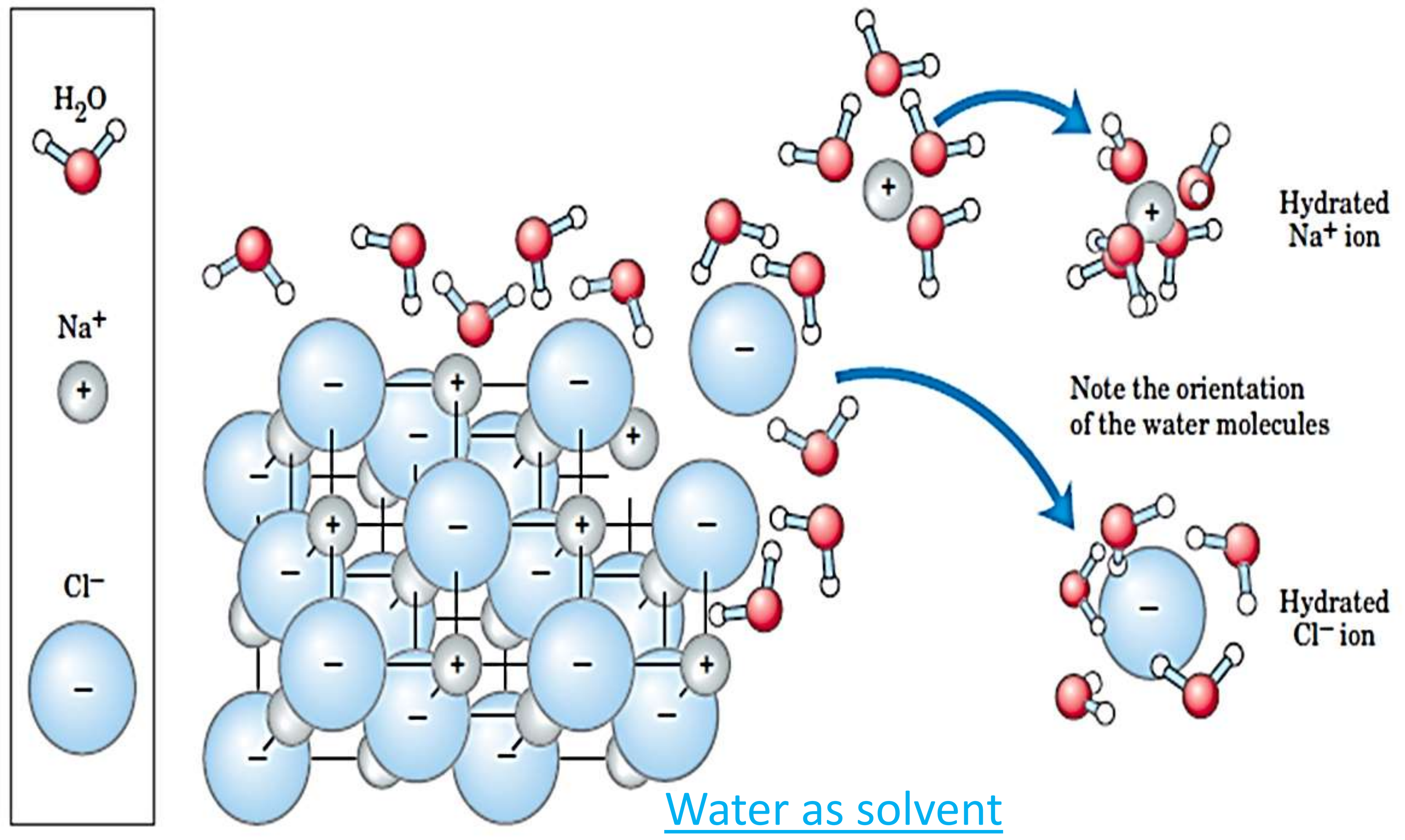


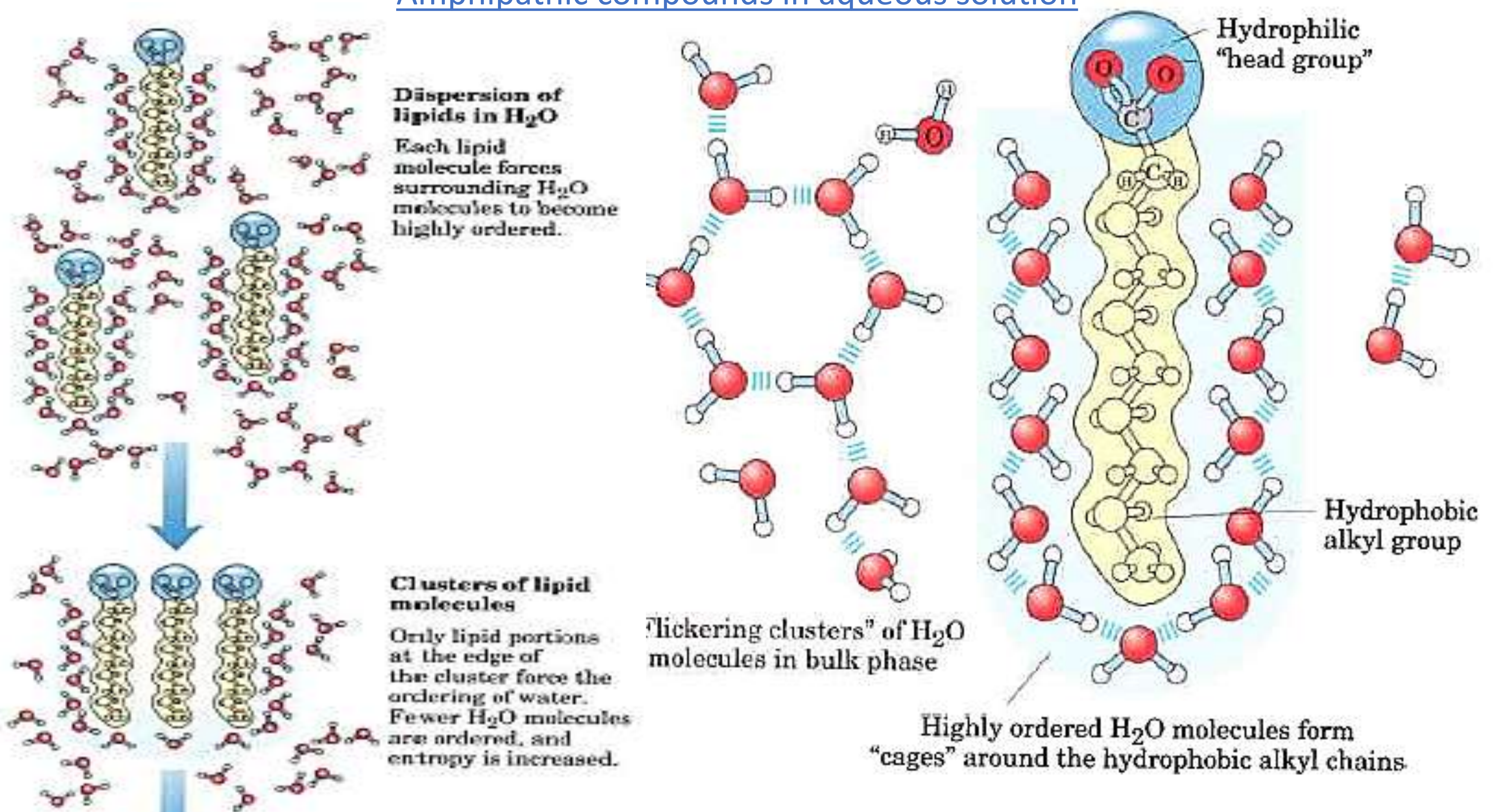
FIGURE 2–1 Structure of the water molecule. (a) The dipolar nature the H_2O molecule is shown in a ball-and-stick model; the dashed li represent the nonbonding orbitals. There is a nearly tetrahed arrangement of the outer-shell electron pairs around the oxygen ato the two hydrogen atoms have localized partial positive charges (and the oxygen atom has a partial negative charge (δ⁻). (b) Two H molecules joined by a hydrogen bond (designated here, and throughout this book, by three blue lines) between the oxygen atom of the upper molecule and a hydrogen atom of the lower one. Hydrogen bonds are longer and weaker than covalent O—H bonds.



Water as solvent

Water dissolves salts such as NaCl by hydrating and stabilizing the Na+ and Cl- ions, weakening the electrostatic interactions between them and thus counteracting their tendency to associate in a crystalline lattice

Amphipathic compounds in aqueous solution



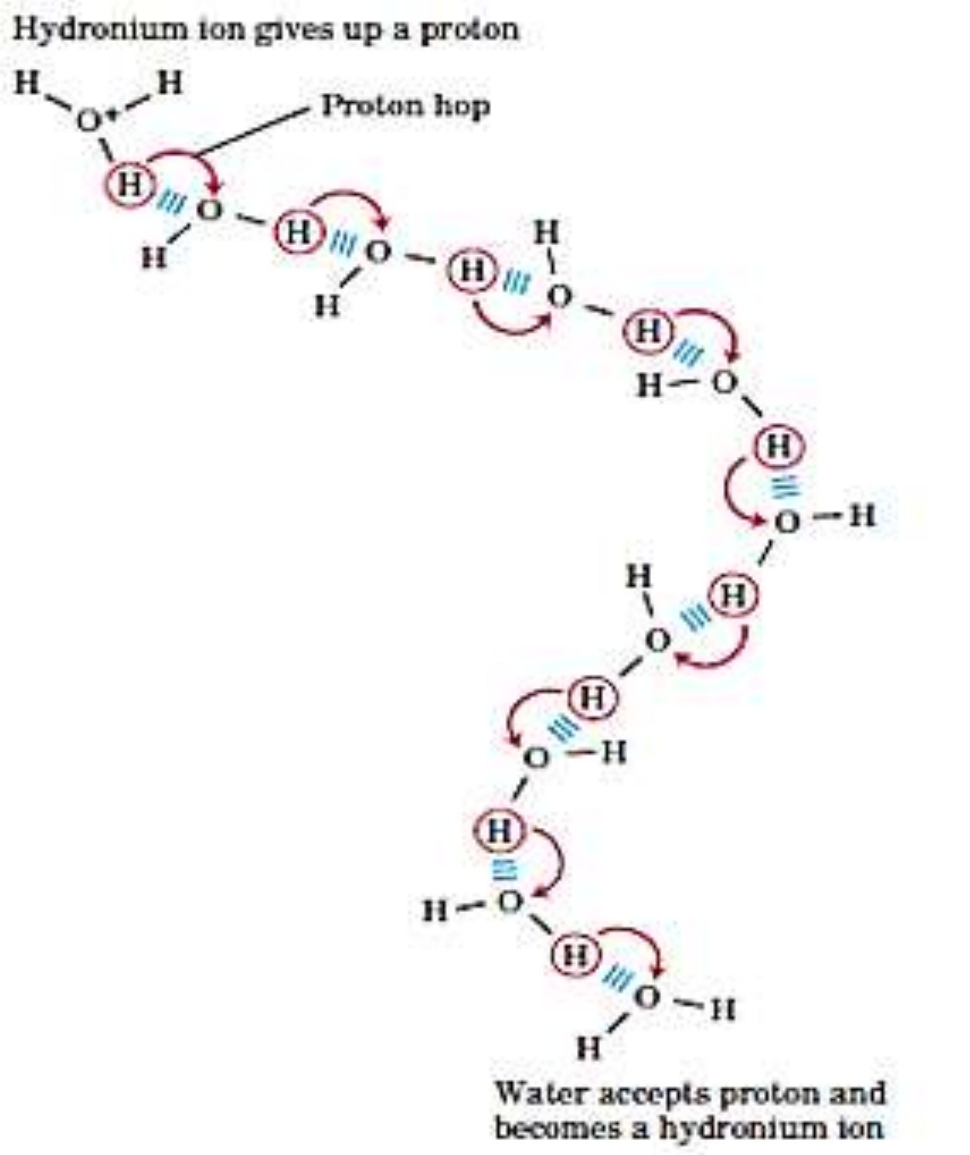


FIGURE 2–14 Proton hopping. Short "hops" of protons between a series of hydrogen-bonded water molecules effect an extremely rapid net movement of a proton over a long distance. As a hydronium ion (upper left) gives up a proton, a water molecule some distance away (lower right) acquires one, becoming a hydronium ion. Proton hopping is much faster than true diffusion and explains the remarkably high ionic mobility of H^+ ions compared with other monovalent cations such as Na^+ or K^+.

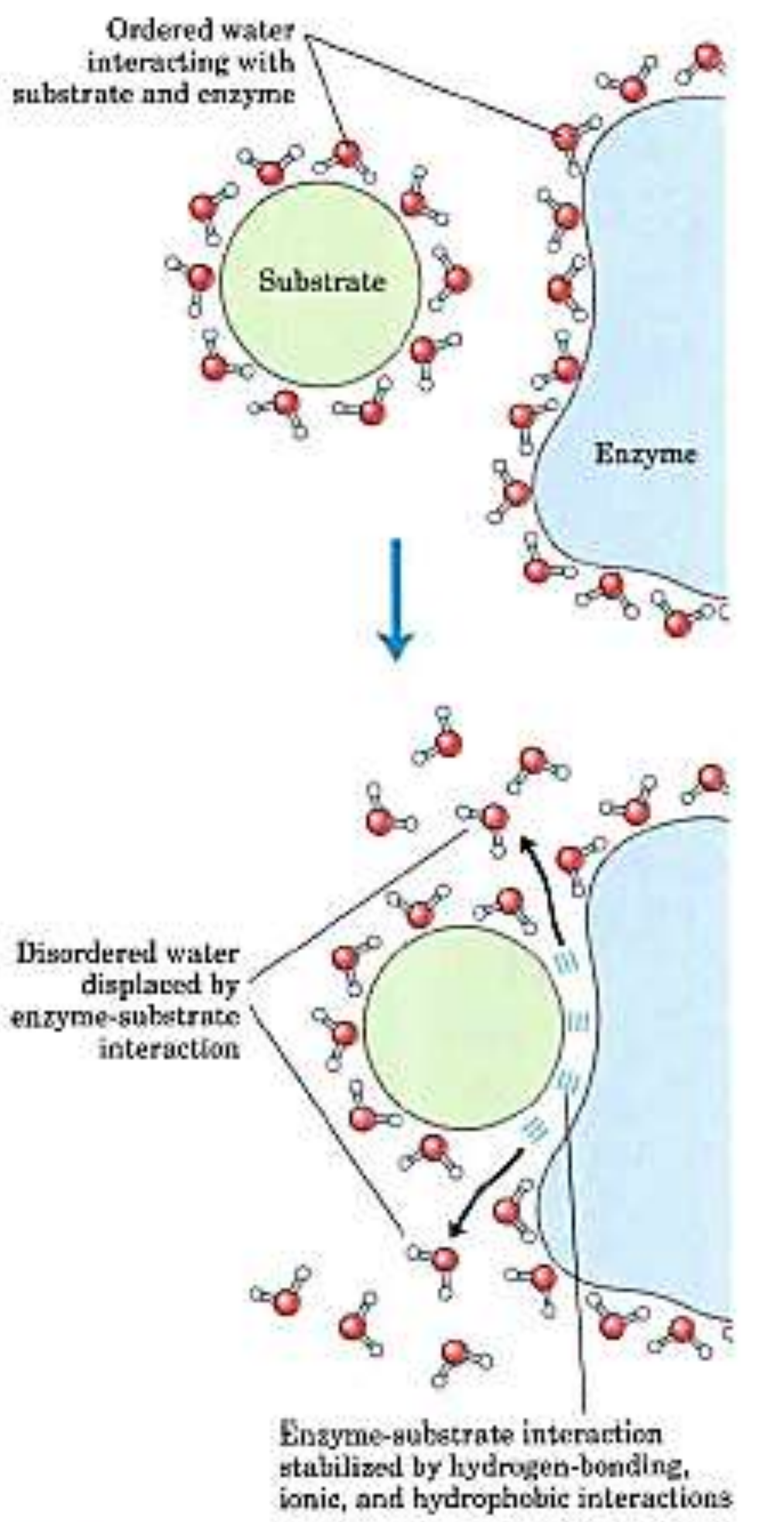


FIGURE 2–8 Release of ordered water favors formation of an enzyme-substrate complex. While separate, both enzyme and substrate force neighboring water molecules into an ordered shell. Binding of substrate to enzyme releases some of the ordered water, and the resulting increase in entropy provides a thermodynamic push toward formation of the enzyme-substrate complex (see p. 192).