Solutions
Part 2 - Colloids

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Colloids

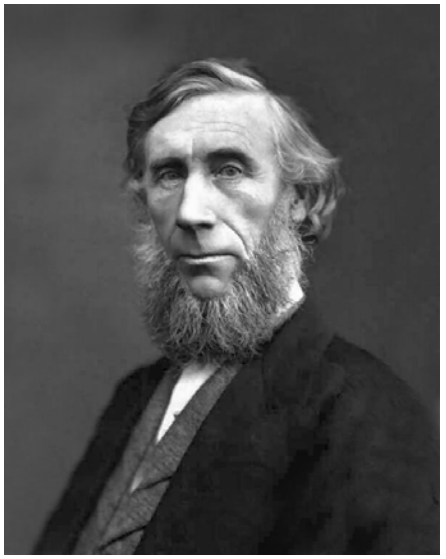
- In true solutions, the maximum diameter of a solute particle is about 1 nm.
- **Colloid**: a solution in which the solute particle diameter is between 1nm and 1000 nm.
- Colloid particles have very large surface areas, which accounts for these two characteristics of colloidal systems;
  - they scatter light and, therefore, appear turbid, cloudy, or milky.
  - they form stable dispersions; that is, they do not settle out.

Types of Colloids

Suspensions of particles larger than individual ions or molecules, but too small to be settled out by gravity.

Phase of Colloid	Dispersing (solventlike) Substance	Dispersed (solutelike) Substance	Colloid Type	Example
Gas	Gas	Gas	—	None (all are solutions)
Gas	Gas	Liquid	Aerosol	Fog
Gas	Gas	Solid	Aerosol	Smoke
Liquid	Liquid	Gas	Foam	Whipped cream
Liquid	Liquid	Liquid	Emulsion	Milk
Liquid	Liquid	Solid	Sol	Paint
Solid	Solid	Gas	Solid foam	Marshmallow
Solid	Solid	Liquid	Solid emulsion	Butter
Solid	Solid	Solid	Solid sol	Ruby glass

Colloids

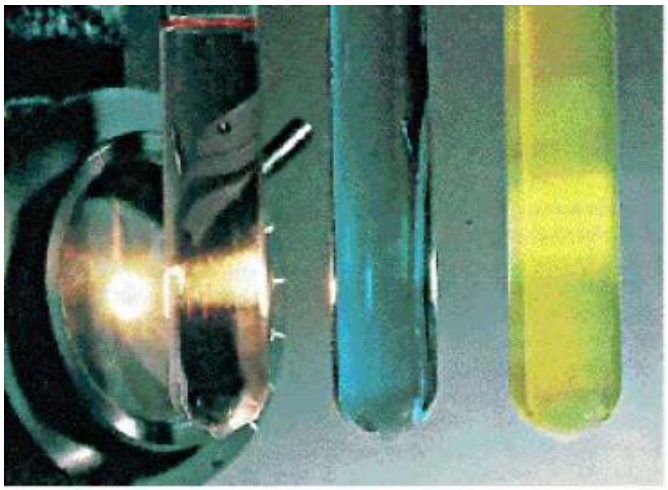


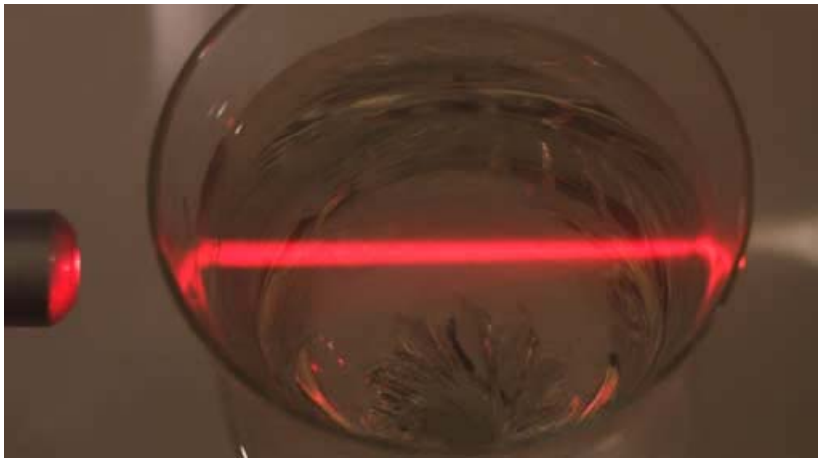
- **John Tyndall (1820-1893)**
- **Tyndall effect: a characteristic of colloids in which light passing through the colloid is scattered (i.e., reflected off of colloidal particles).**

Examples of colloids that exhibit the Tyndall effect are smoke, serum, and fog.

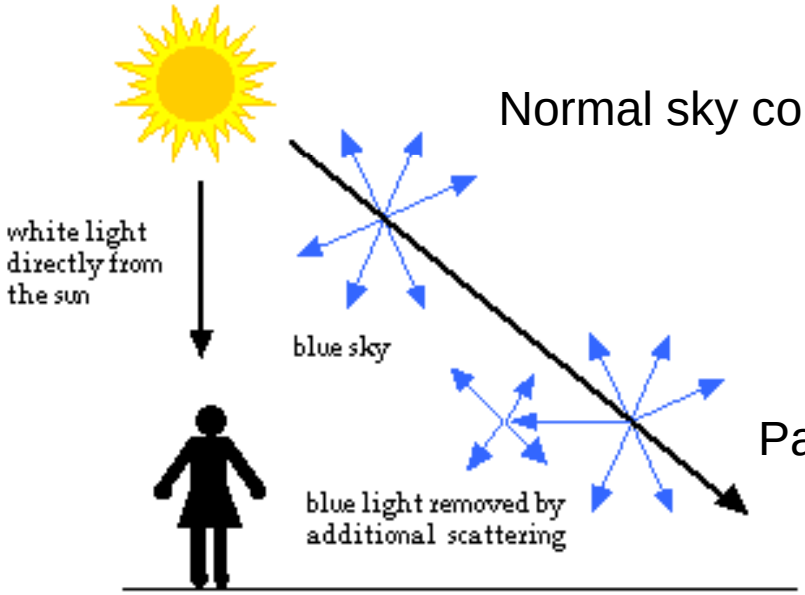
Colloids

- **Tyndall effect**



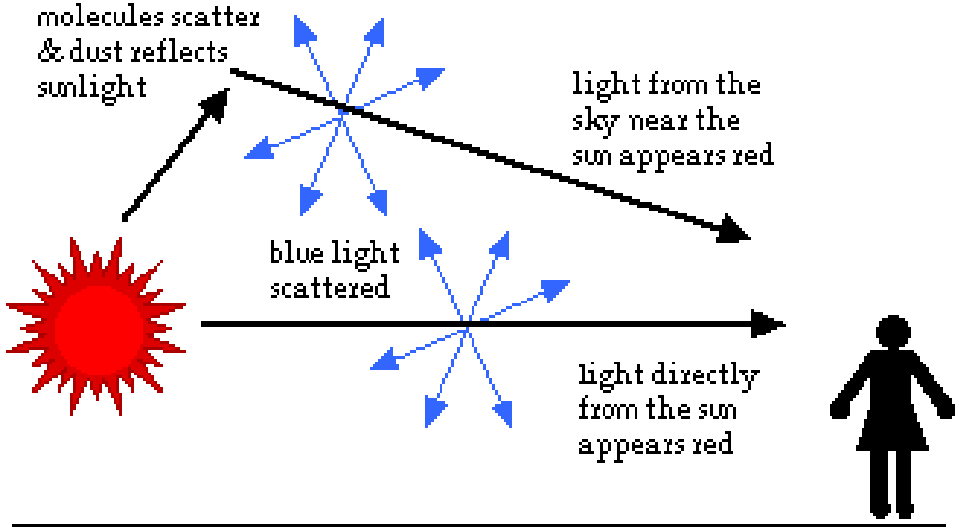


Why is the sky blue?



Normal sky color

Pale blue sky near horizon

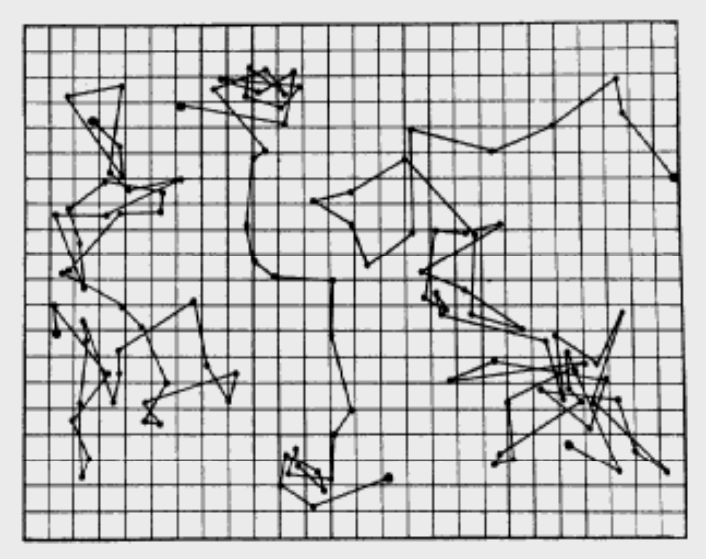


Colloids

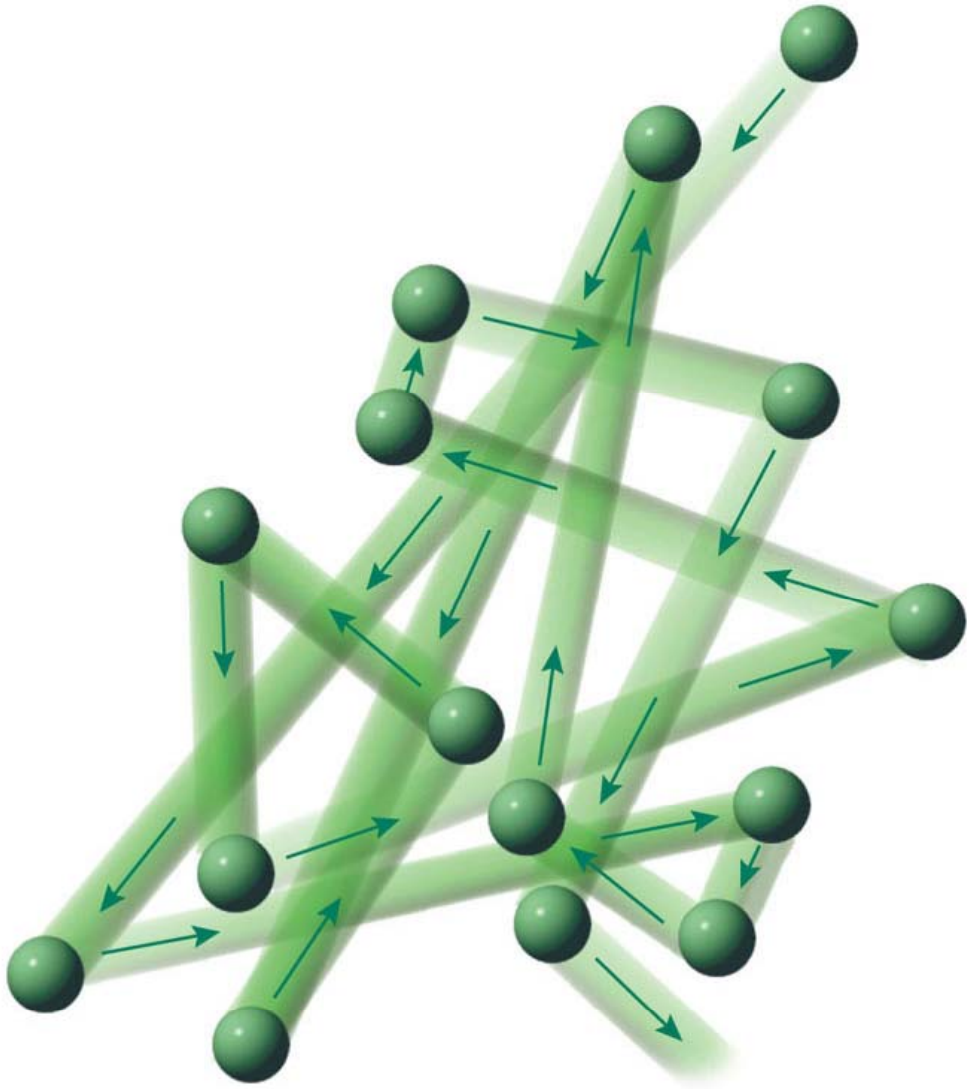
- Robert Brown (1773-1858)
- In 1827 the English botanist Robert Brown noticed that pollen grains suspended in water jiggled about under the lens of the microscope, following a zigzag path.
- **Brownian motion:** the random motion of colloid-size particles.

Colloids

- **Examples of Brownian motion are the motion of dust particles in the air; what we see are the dust particles due to scattered light.**

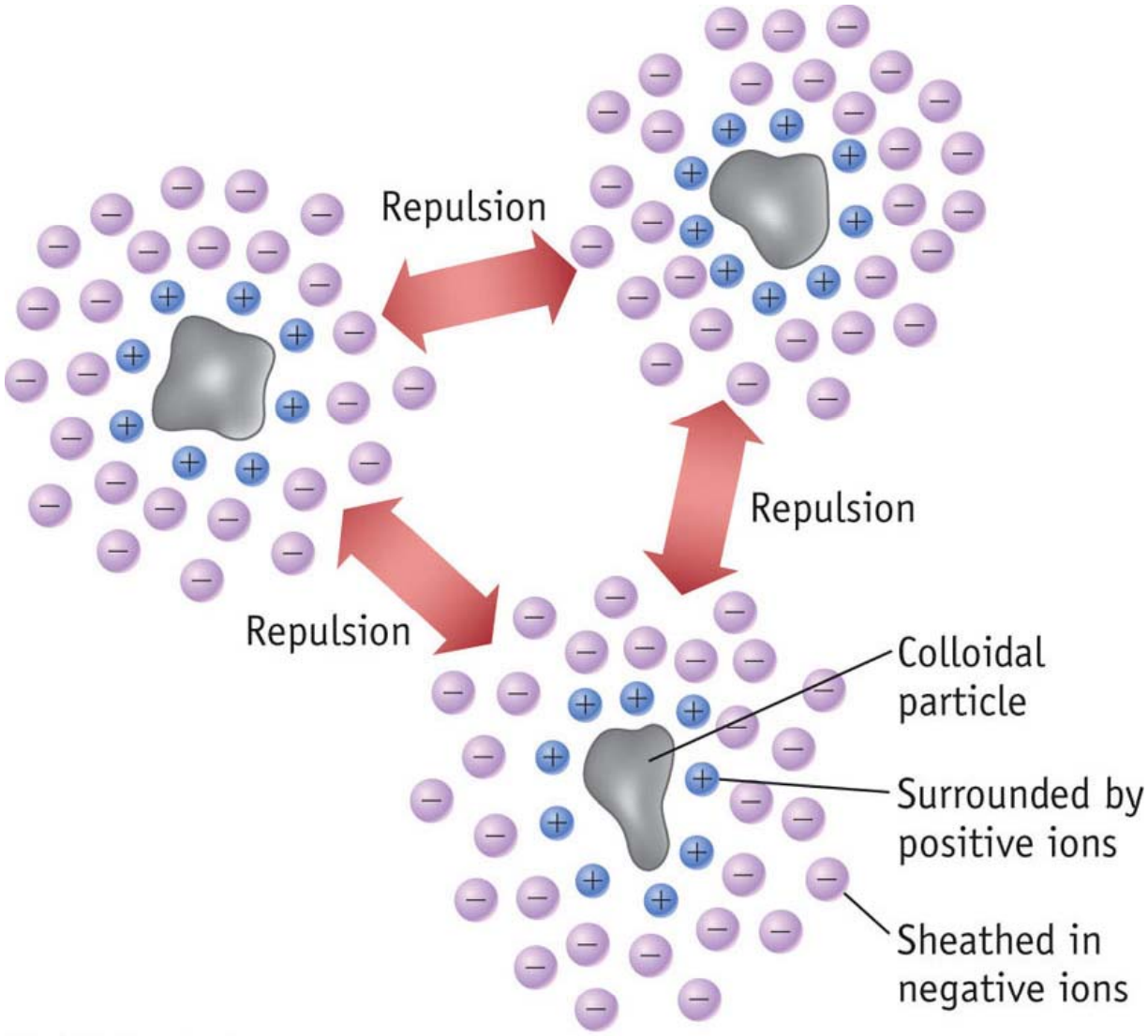


Joseph Perrin 1908



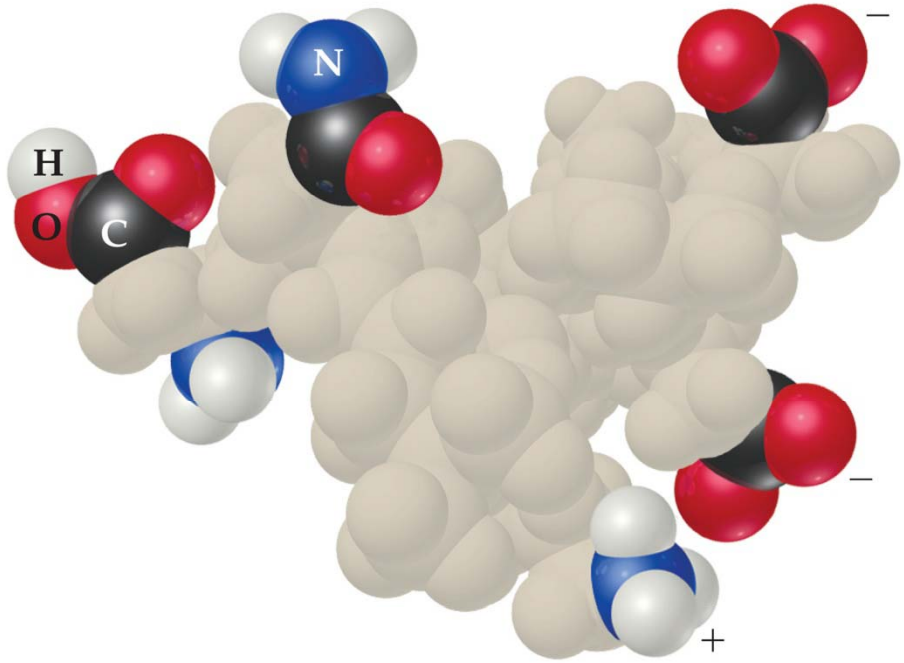
Colloids

- **Why do colloidal particles remain in solution despite all the collisions due to Brownian motion?**
  - **Most colloidal particles carry a large solvation layer; if the solvent is water, as in the case of protein molecules in the blood, the large number of surrounding water molecules prevents colloidal molecules from touching and sticking together.**
  - **Because of their large surface area, colloidal particles acquire charges from solution; for example, they all may become negatively charged. When a charged colloidal particle encounters another particle of the same charge, they repel each other.**

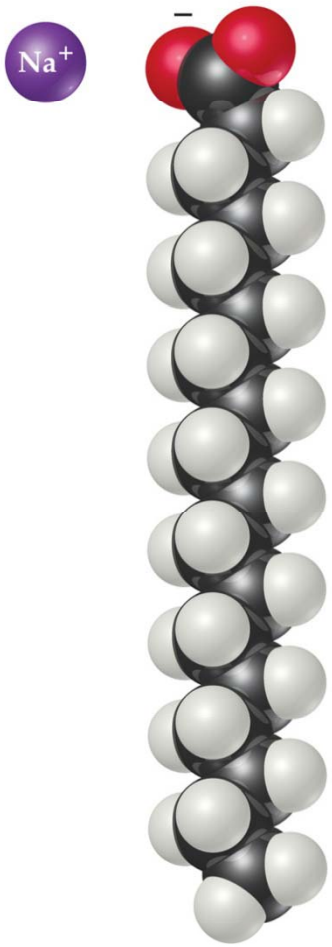


Colloids in Biological Systems

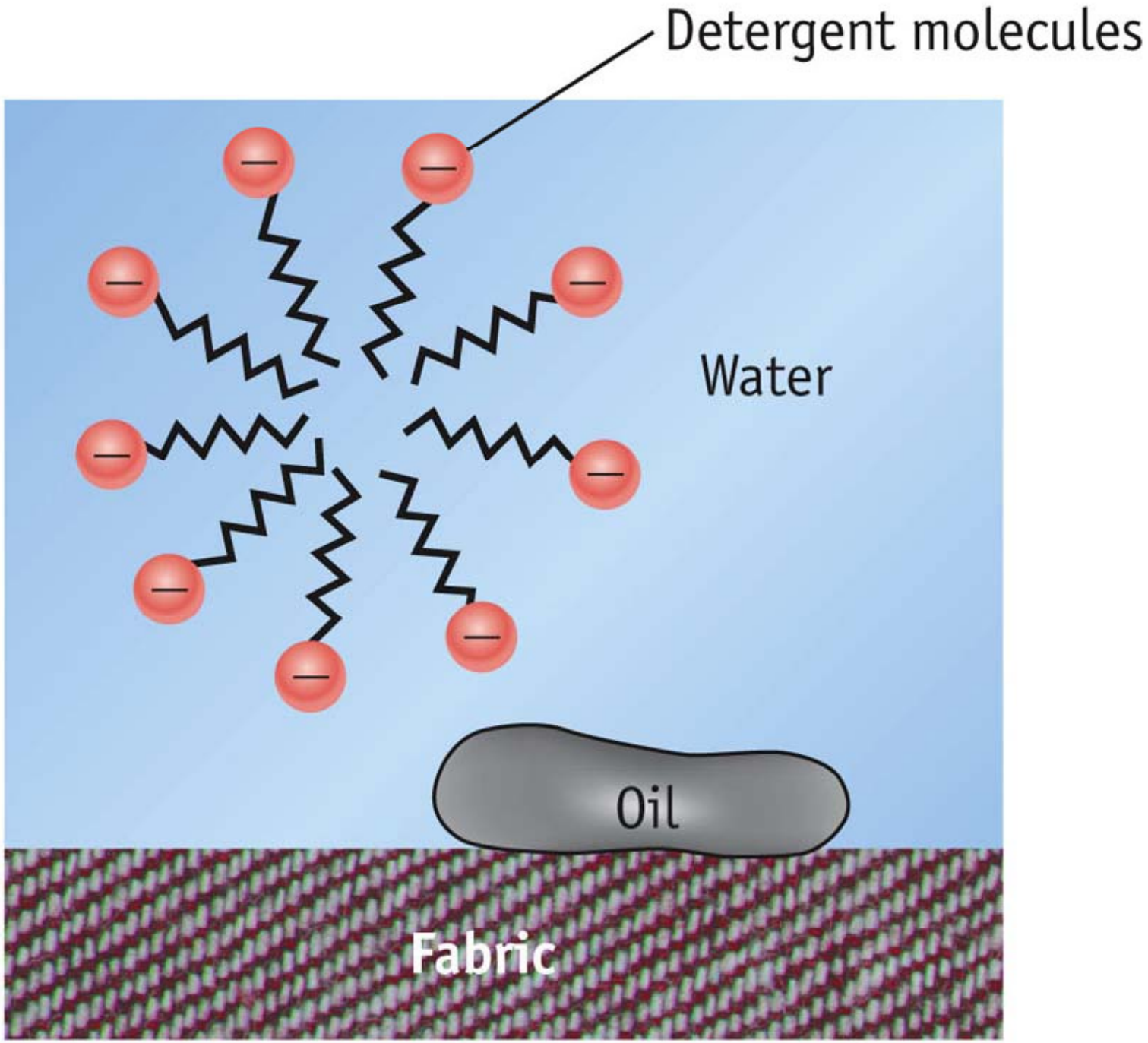
Some molecules have a polar, hydrophilic (*water-loving*) end and a nonpolar, hydrophobic (*water-hating*) end.



Colloids in Biological Systems



Sodium stearate is one example of such a molecule.



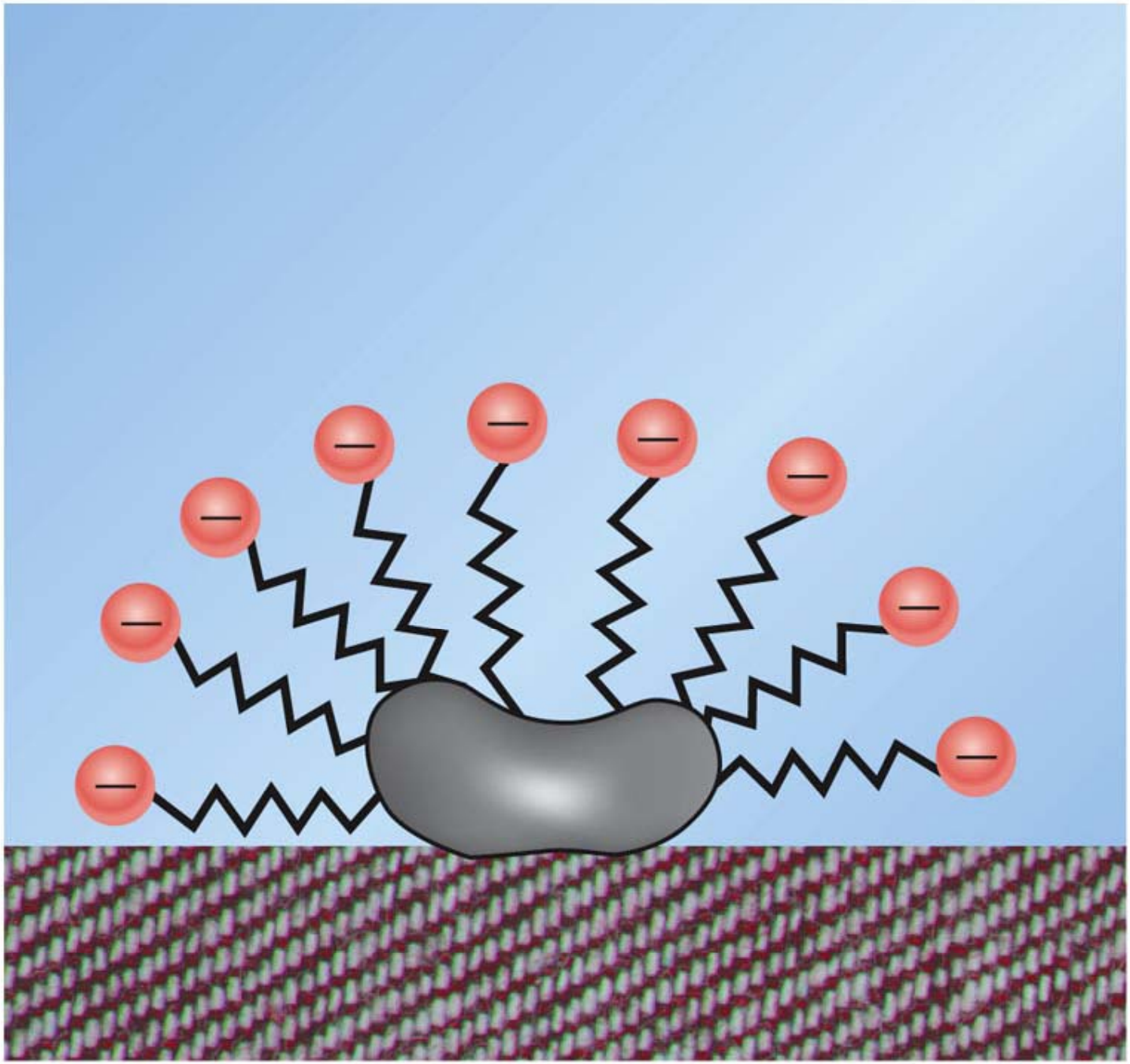
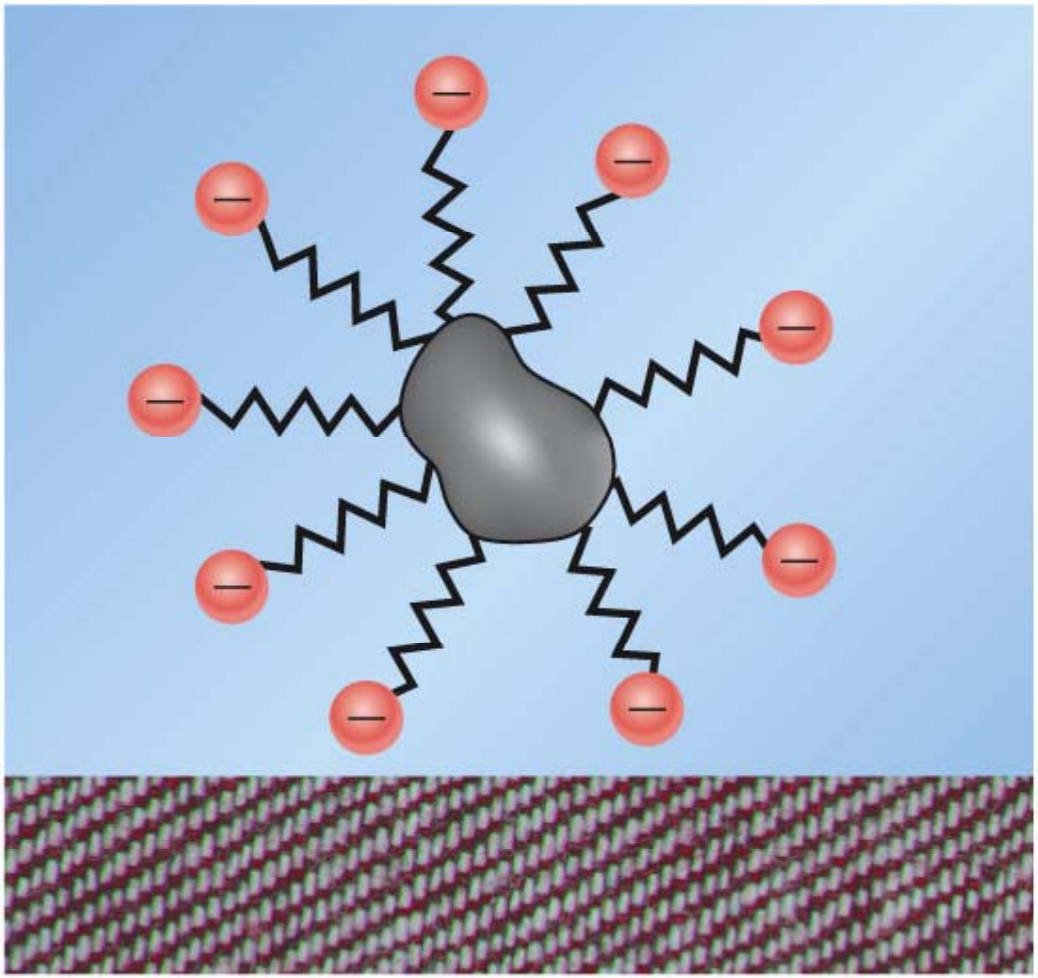


Fig. 14-22, p. 645



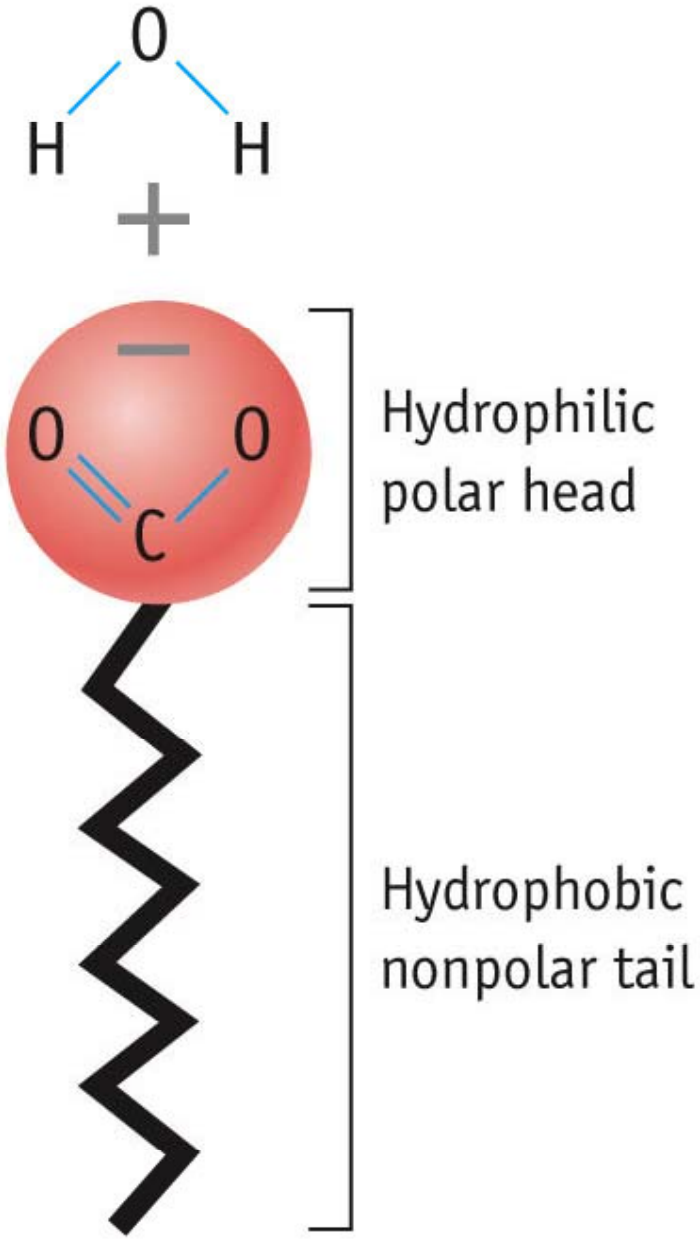
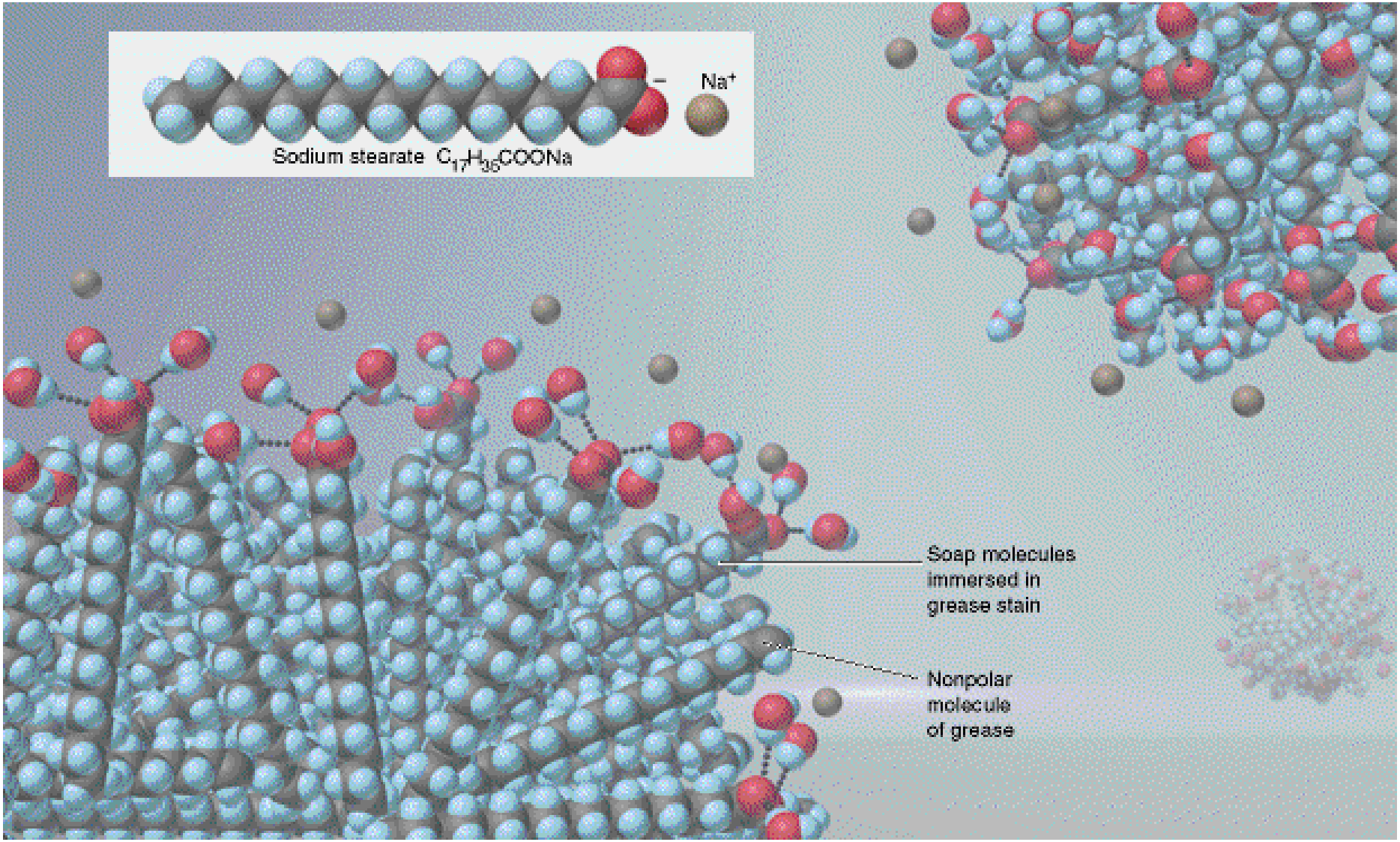


Fig. 14-22, p. 645


Sodium stearate $C_{17}H_{35}COONa$
Na^+
Soap molecules immersed in grease stain
Nonpolar molecule of grease