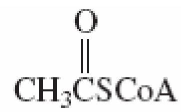
Lipids

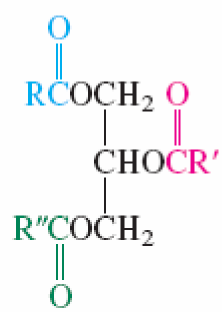
SUMMARY

Section 26.1 Chemists and biochemists find it convenient to divide the principal organic substances present in cells into four main groups: *carbohydrates, proteins, nucleic acids,* and **lipids.** Structural differences separate carbohydrates from proteins, and both of these are structurally distinct from nucleic acids. Lipids, on the other hand, are characterized by a *physical property,* their solubility in nonpolar solvents, rather than by their structure. In this chapter we have examined lipid molecules that share a common biosynthetic origin in that all their carbons are derived from acetic acid (acetate). The form in which acetate occurs in many of these processes is a thioester called acetyl coenzyme A.



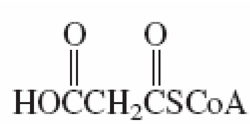
Abbreviation for acetyl coenzyme A
(for complete structure, see Figure 26.1)

Section 26.2 Acetyl coenzyme A is the biosynthetic precursor to the **fatty acids,** which most often occur naturally as esters. **Fats** and **oils** are glycerol esters of long-chain carboxylic acids. Typically, these chains are unbranched and contain even numbers of carbon atoms.



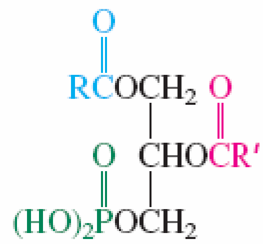
Triacylglycerol
(R, R′, and R″ may be the same or different)

Section 26.3 The biosynthesis of fatty acids follows the pathway outlined in Mechanism 26.1. Malonyl coenzyme A is a key intermediate.



Malonyl coenzyme A

Section 26.4 **Phospholipids** are intermediates in the biosynthesis of triacylglycerols from fatty acids and are the principal constituents of the lipid bilayer component of cell membranes.

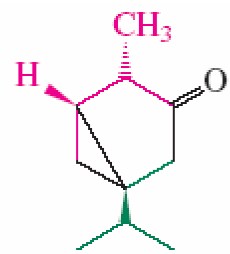


A phospholipid

Section 26.5 **Waxes** are mixtures of substances that usually contain esters of fatty acids and long-chain alcohols.

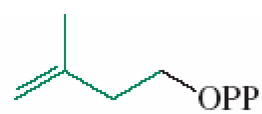
Section 26.6 **Icosanoids** are a group of naturally occurring compounds derived from unsaturated C_{20} carboxylic acids. Icosanoids include **prostaglandins, prostacyclins, thromboxanes,** and **leukotrienes.** Although present in very small amounts, icosanoids play regulatory roles in a very large number of biological processes.

Section 26.7 **Terpenes** have structures that follow the isoprene rule in that they can be viewed as collections of isoprene units.



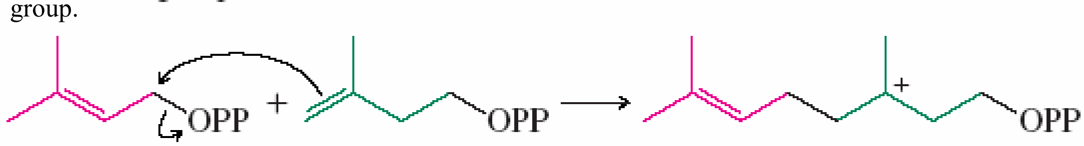
β-Thujone: a toxic monoterpene present in absinthe

Section 26.8 Terpenes and related *isoprenoid* compounds are biosynthesized from *isopentenyl pyrophosphate.*

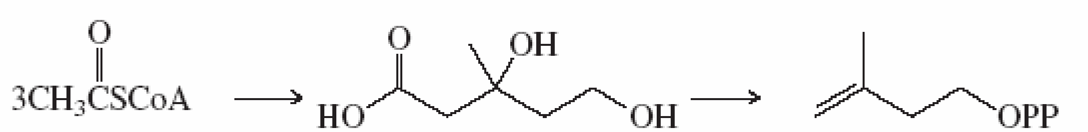


Isopentenyl pyrophosphate is the "biological isoprene unit."

Section 26.9 Carbon–carbon bond formation between isoprene units can be understood on the basis of nucleophilic attack of the p electrons of a double bond on a carbocation or an allylic carbon that bears a pyrophosphate leaving group.



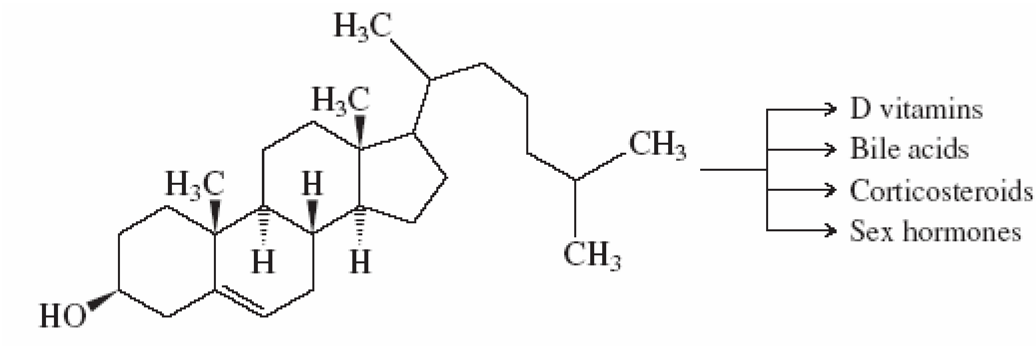
Section 26.10 The biosynthesis of isopentenyl pyrophosphate begins with acetate and proceeds by way of *mevalonic acid.*



Acetyl coenzyme A Mevalonic acid Isopentenyl pyrophosphate

Section 26.11 The triterpene *squalene* is the biosynthetic precursor to cholesterol by the pathway shown in Mechanism 26.2.

Sections 26.12–26.15 Most of the steroids in animals are formed by biological transformations of cholesterol.



Cholesterol

Section 26.16 **Carotenoids** are tetraterpenes. They have 40 carbons and numerous double bonds. Many of the double bonds are conjugated, causing carotenes to absorb visible light and be brightly colored. They are often plant pigments.