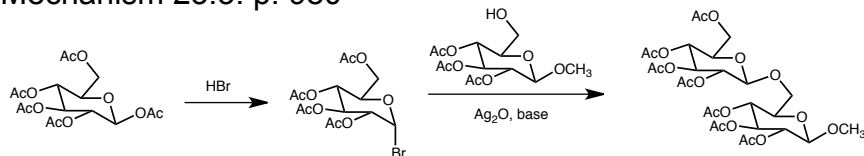


23.24: Glycosides: Synthesis of Oligosaccharides

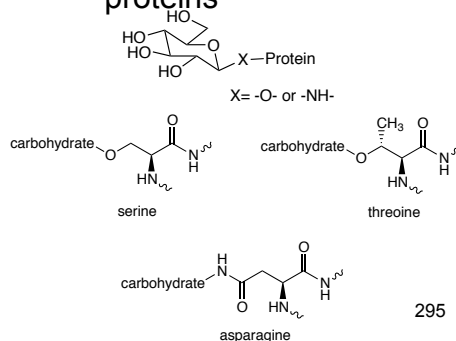
Mechanism 23.3: p. 980



23.25: Glycobiology (please read)



Glycoproteins: glycosides of proteins



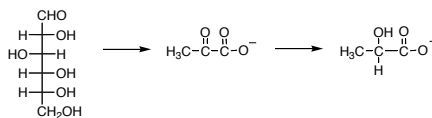
295

Chapter 24: Lipids. Hydrophobic (non-polar, soluble in organic solvent), typically of low molecular weight compounds of organic origin.

- fatty acids and waxes
- essential oils
- many vitamins
- hormones (non-peptide)
- components of cell membranes (non-peptide)

Share a common biosynthesis that ultimately derives their carbon source from glucose (glycolysis)

Glucose \rightarrow pyruvate \rightarrow lactate



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24.1: Acetyl Coenzyme A. AcSCoA is a thioester.

R= H, HSCoA

R= acetyl, AcSCoA

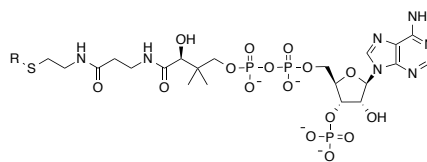
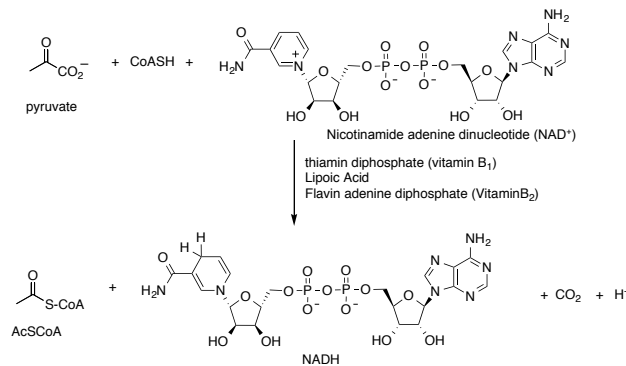


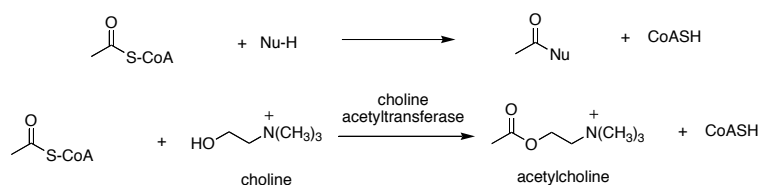
Fig 24.1,
p. 993

Pyruvate dehydrogenase: Multi-enzyme complex that converts pyruvate to AcSCoA.

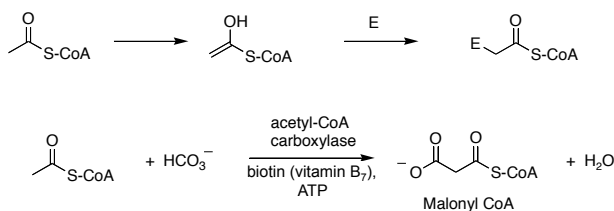


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Acetyl CoA is a thioester. Thioesters are more reactive toward nucleophilic acyl substitution than esters, but considerably less reactive than acid chlorides and anhydrides.



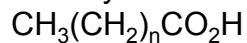
Thioester enolize more readily than esters. The enol can react with electrophile to afford α -substitution products



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24.2: Fats, Oils, and Fatty Acids. *Fatty acids:* refers to long, straight-chain saturated and unsaturated carboxylic acids, typically between C₁₂ - C₂₀ (Table 24.1, p. 995).

saturated fatty acids:



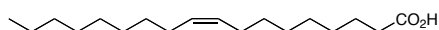
n=10, lauric acid (C₁₂)

n=12, myristic acid (C₁₄)

n=14, palmitic acid (C₁₆)

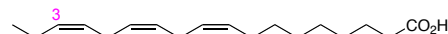
n=16, steric acid (C₁₈)

unsaturated fatty acid

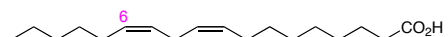


C₁₈, oleic acid

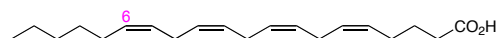
polyunsaturated fatty acids (PUFA)



C₁₈, linolenic acid (18:3)



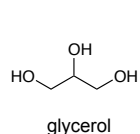
C₁₈, linoleic acid (18:2)



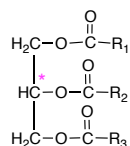
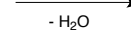
C₂₀, arachidonic acid (20:4)

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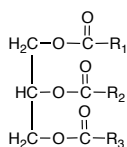
Fats and Oils: Triglycerides (triacylglycerols) are tri-esters of glycerol (1,2,3-trihydroxypropane) and fatty acids.



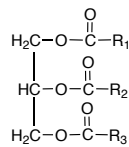
+ fatty acids



The R groups can be saturated or unsaturated, the same or different

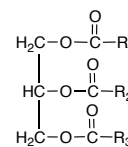


when some of the R groups are unsaturated
→
H₂, catalyst



Partially hydrogenated: some cis double bond are isomerized to trans double bonds

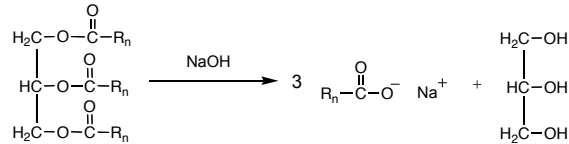
→
H₂, catalyst



Hydrogenated- only saturated fatty acids

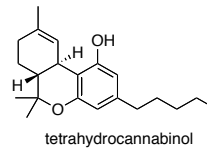
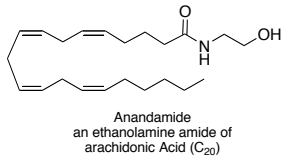
300

Soaps: sodium & potassium salts of fatty acid produced from the saponification (base hydrolysis) of animal fats (glycerides)



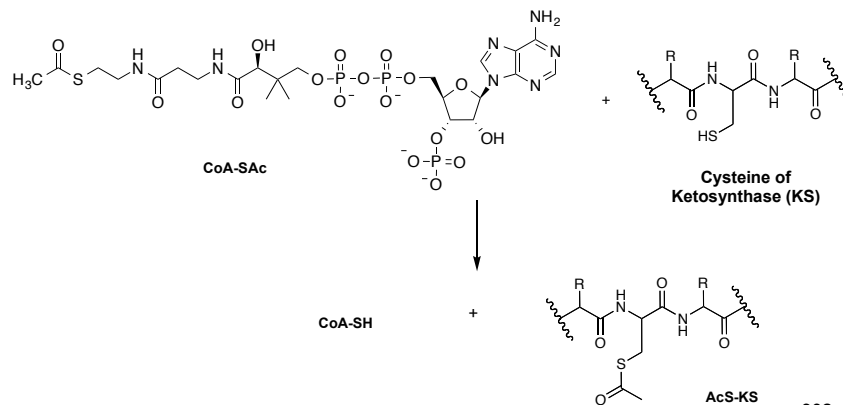
Soaps have a hydrophilic, polar “head group” (carboxylate salt) and a hydrophobic, non-polar “tail” (Ch. 18.7).

Fatty acid amides (FAA):



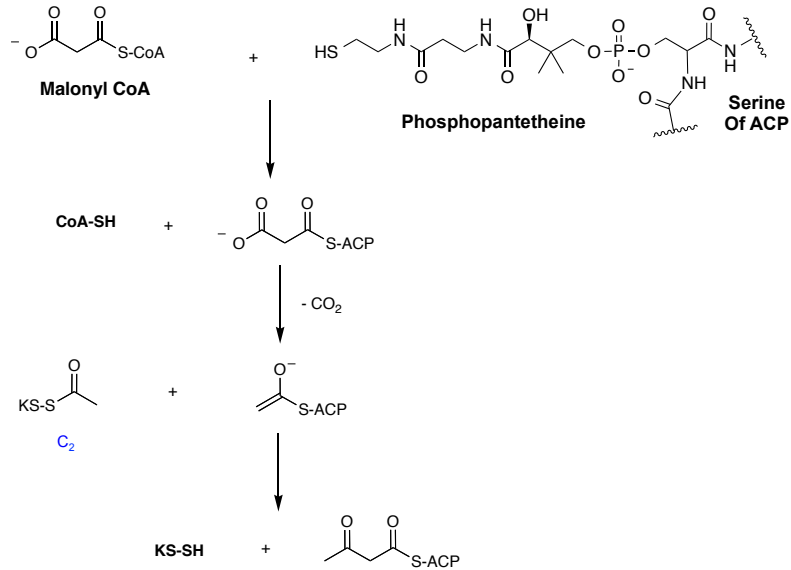
301

24.3: Fatty Acid Biosynthesis. Fatty acid biosynthesis is performed by a cluster of discrete enzymes in bacteria, and a very large multi-protein assembly in animals (*fatty acid synthase*, FAS). The fatty acid is attached to an *acyl carrier protein* (ACP), while other proteins perform an iterative two-carbon chain extension reaction that will yield the fatty acid.

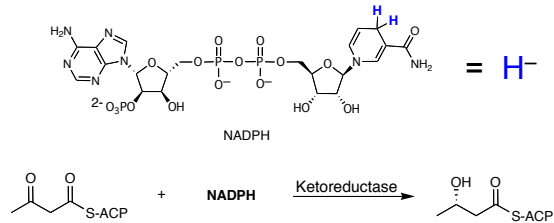


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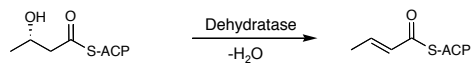
Fatty acid synthase chain extension reaction:
Ketosynthase (KS)



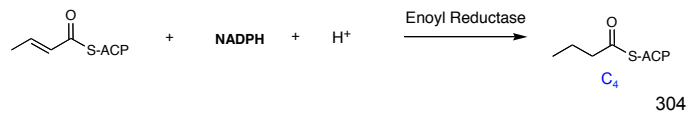
Ketoreductase (KR): NADPH (nicotinamide adenine diphosphate phosphate) is a nucleophilic hydride (H^-) donor (reducing agent)



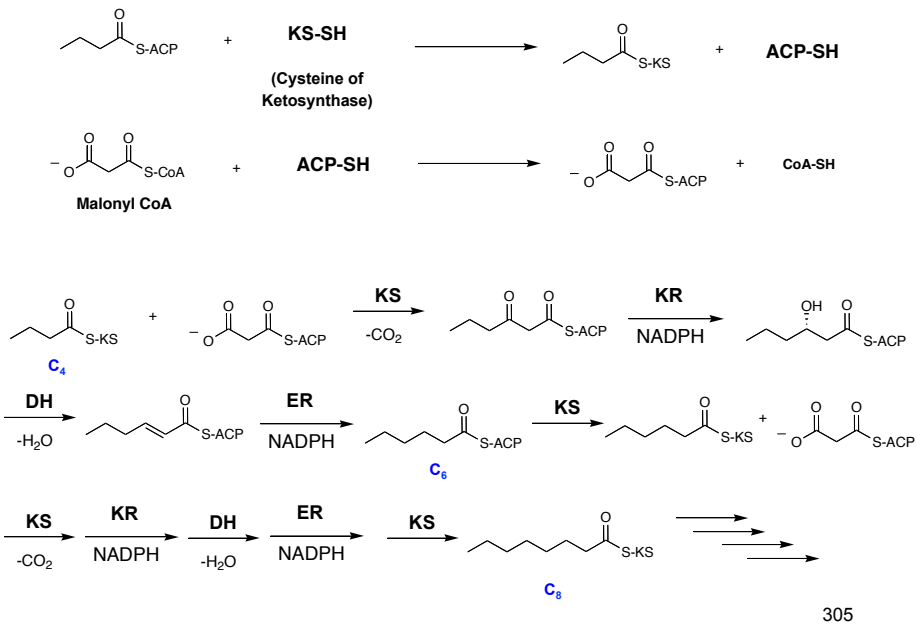
Dehydratase (DH):



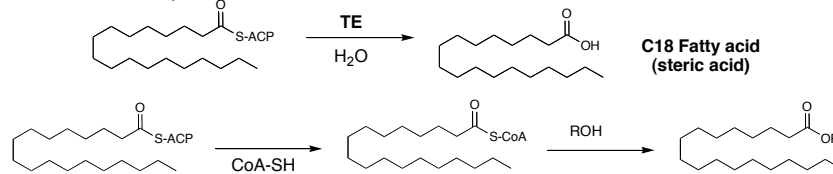
Enoyl Reductase (ER)



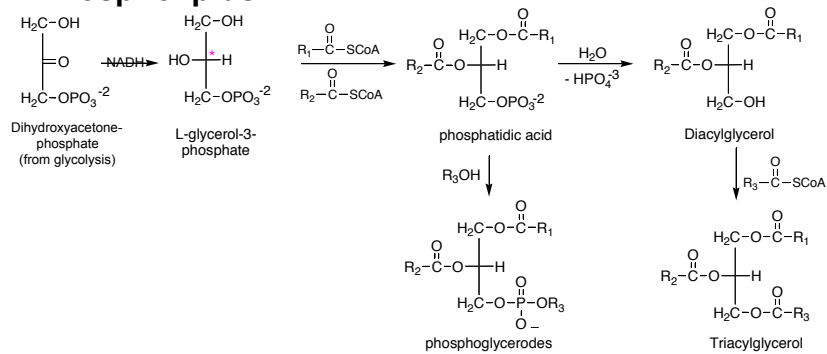
Iterative two-carbon chain extension



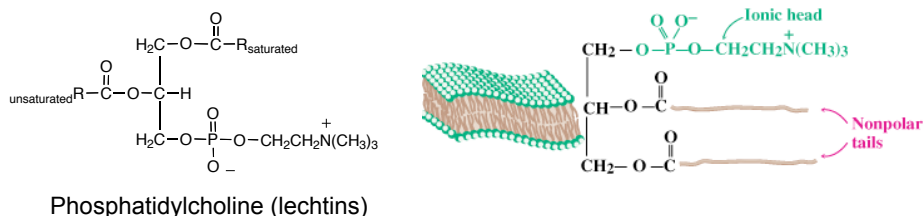
Thioesterase (TE)



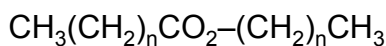
24.4 Phospholipids.



Glycerophospholipids are important components of cell membranes. Nonpolar tails aggregate in the center of a bilayer ionic head is exposed to solvent.



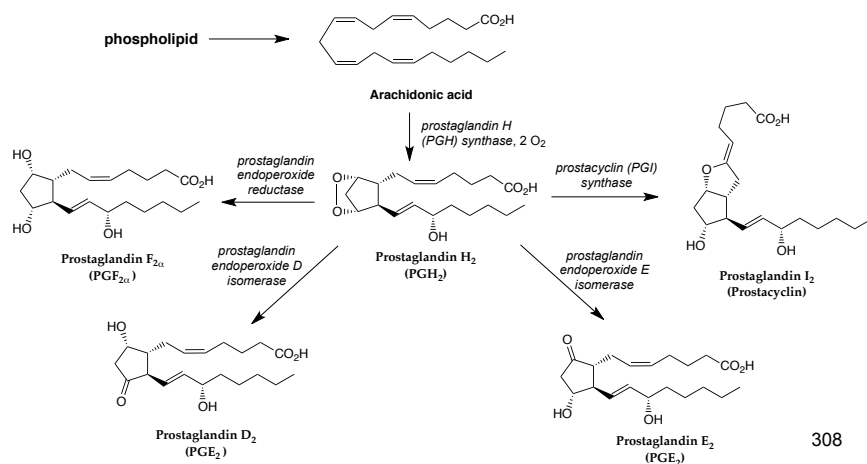
24.5: Waxes. esters of long chain fatty acids ($C_{16} - C_{36}$) with long chain alcohols ($C_{24} - C_{36}$)



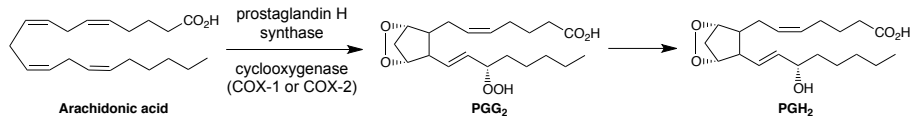
307

24.6: Prostaglandins. (*eicosanoids*) C_{20} compounds derived from arachidonic acid and related fatty acids

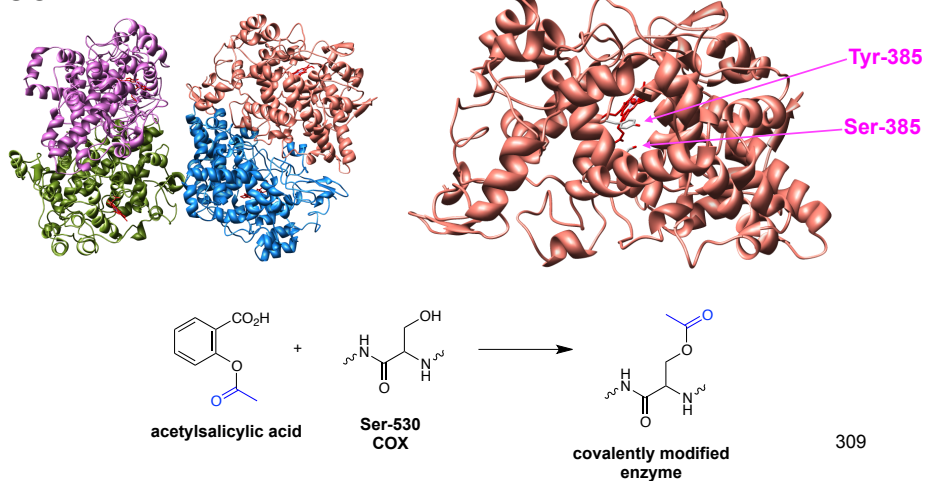
hormone: (Greek, *horman*, to set in motion) chemical messengers from one cell to another, that acts as a signal for a biochemical event.



Prostaglandin biosynthesis:



COX-2

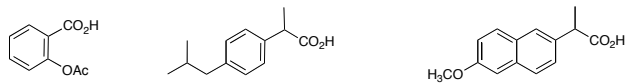


COX-1 is a constitutive enzyme that is expressed in virtually all mammalian cells

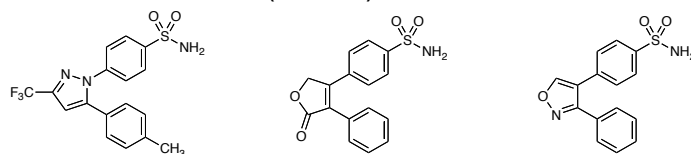
COX-2 is an inducible enzyme that is expressed as a result of a biochemical response; expressed in phagocytes (macrophages) as part of an inflammation response.

NSAIDs: non-steroidal anti-inflammatory drugs

Aspirin, ibuprofen, and naproxen are non-selective inhibitors of COX

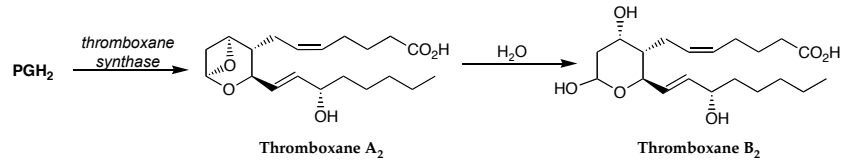


Celebrex, viox, and brextra are selective inhibitors of COX-2 (coxibs)

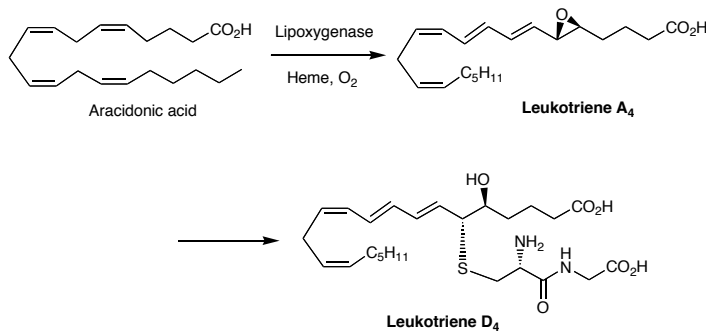


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Thromboxanes: named for their role in thrombosis, the formation of a clot inside a blood vessel



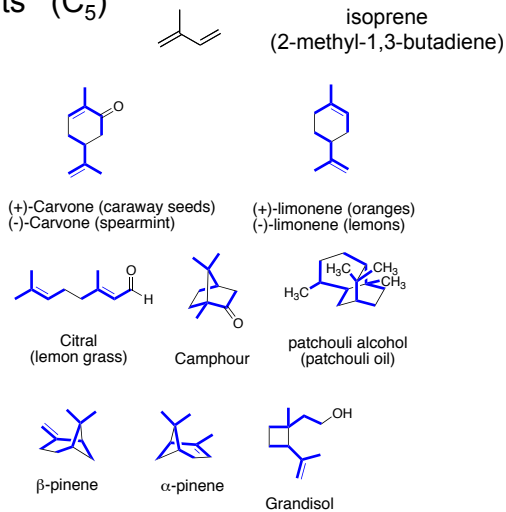
Leukotrienes



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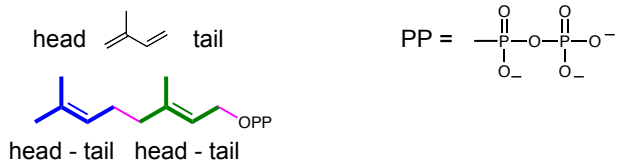
24.7: Terpenes: The Isoprene Rule. Isoprenoids - C_{10} (*terpenes*), C_{15} (*sesquiterpenes*) and C_{20} (*diterpenes*) compounds from plants; essential oils (Table 24.2; p. 1006)

Ruzicka isoprene rule: terpenoids are derived from “isoprene units” (C_5)

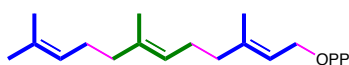


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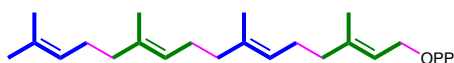
The precursor to C₁₀ terpenoids (*monoterpenes*) is *geranyl diphosphate*, which consists of two C₅ “isoprene units” that are joined “head-to-tail”



C₁₅ sesquiterpenoids are derived from *farnesyl diphosphate*, which consists of three C₅ “isoprene units” that are joined “head-to-tail”

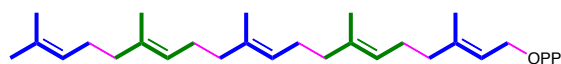


C₂₀ diterpenoids are derived from *geranylgeranyl diphosphate*, which consists of four C₅ “isoprene units” that are joined “head-to-tail”

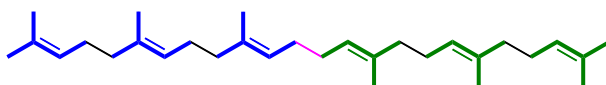


313

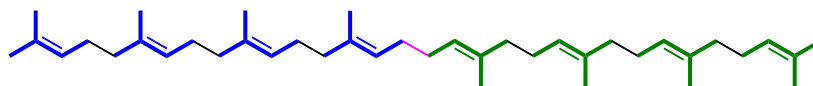
C₂₅ sesterpenoids are derived from *geranylfarnesyl diphosphate*, which consists of five C₅ “isoprene units” that are joined “head-to-tail”



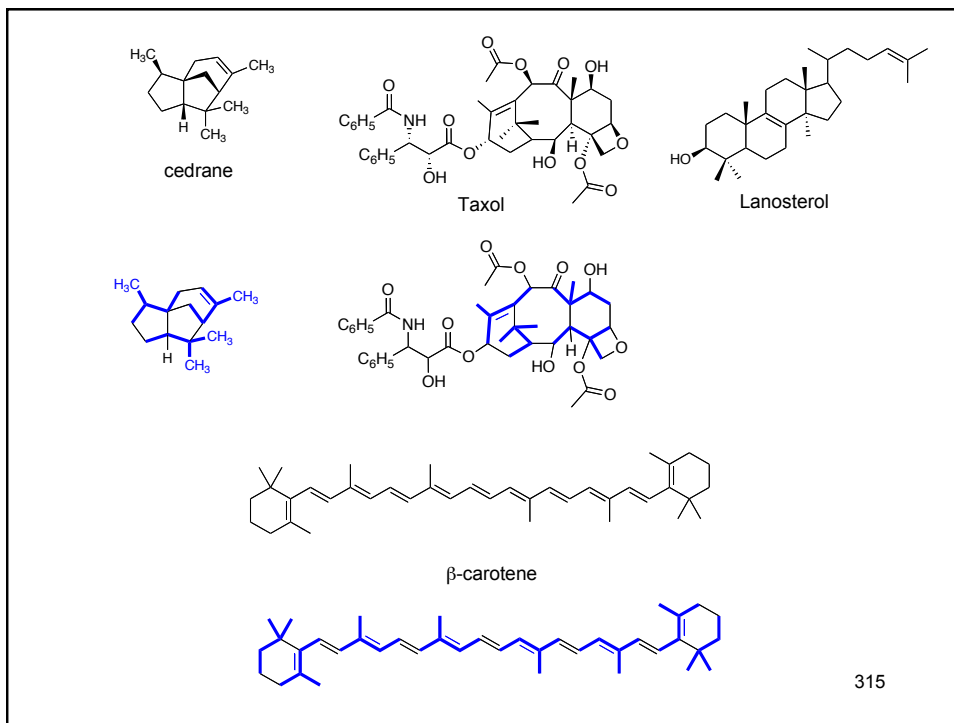
C₃₀ triterpenoids and *steroids* are derived from *squalene*, which consists of two C₁₅ farnesyl units” that are joined “tail-to-tail”



C₄₀ tetraterpenoids are derived from *phytycene*, which consists of two C₂₀ geranylgeranyl units” that are joined “tail-to-tail”



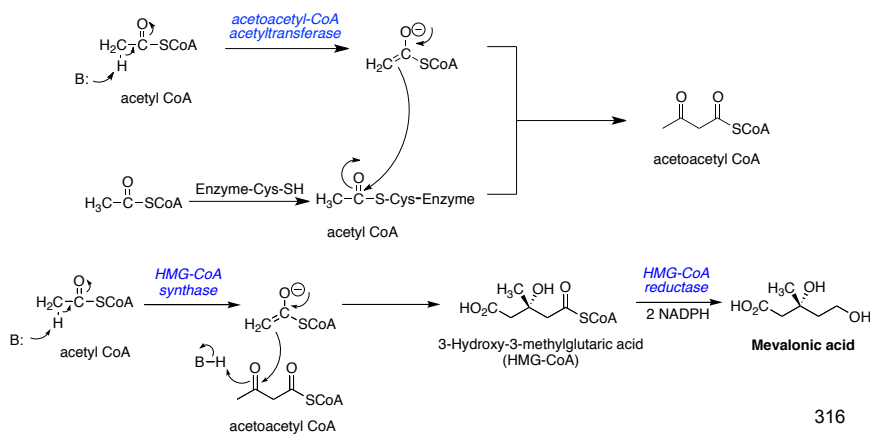
314



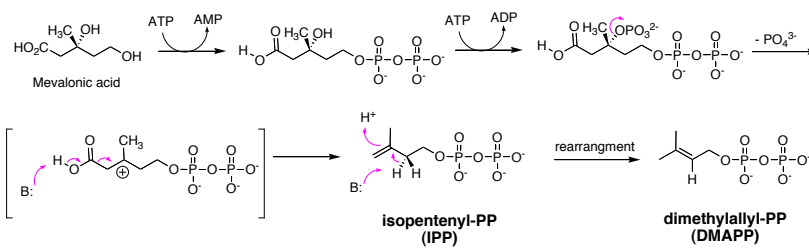
24.8: Isopentyl Diphosphate: The Biological Isoprene Unit.

Mevalonic acid is the biosynthetic precursor to the actual C_5 "isoprene units," which are *isopentyl diphosphate* (IPP, tail) and *dimethylallyl diphosphate* (DMAPP, head)

24.10: The Pathway from Acetate to Isopentenyl Diphosphate. Mevalonate Pathway

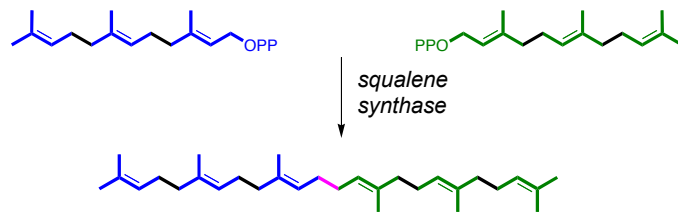
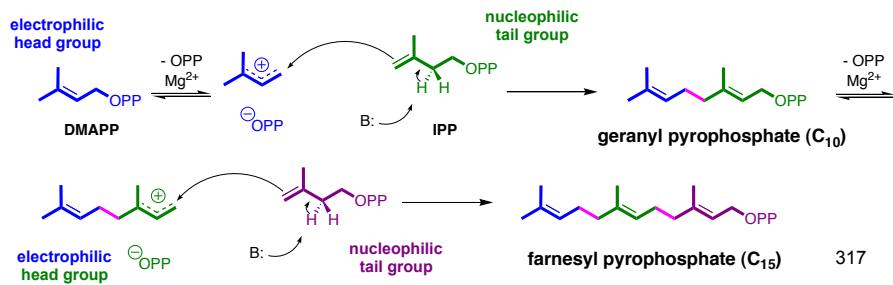


Conversion of mevalonic acid to IPP and DMAPP



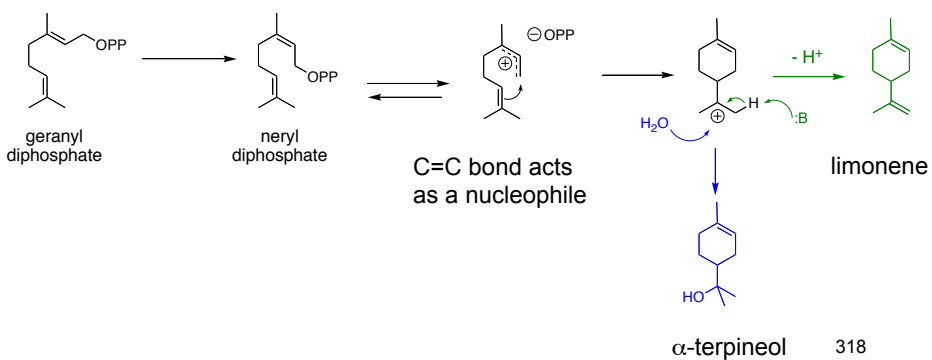
24.9: Carbon-Carbon Bond Formation in Terpene Biosynthesis.

Conversion of IPP and DMAPP to geranyl-PP and farnesyl-PP

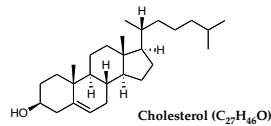
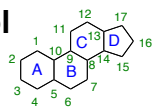


Conversion of geranyl-PP to monoterpenes

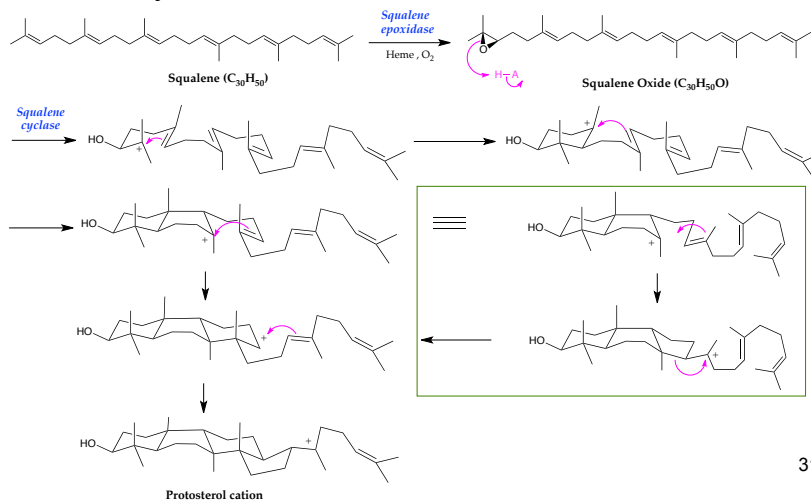
Limonene & α -Terpineol



24.11: Steroids: Cholesterol

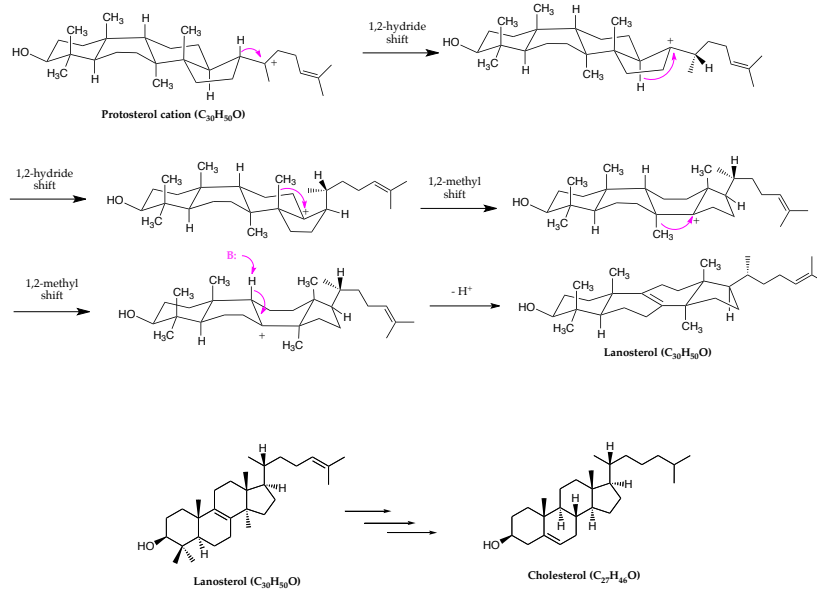


Cholesterol biosynthesis (mechanism 24.1: p. 1015) part a: the cyclization



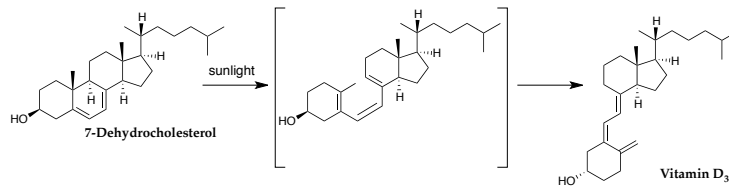
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Cholesterol biosynthesis, part b: the 1,2-shifts

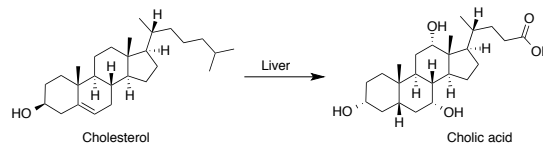


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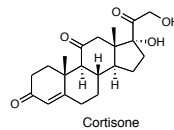
24.12: Vitamin D. (please read)



24.13: Bile Acids. (please read)



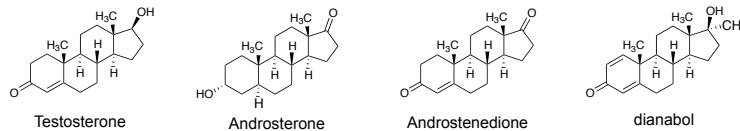
24.14: Corticosteroids. (please read)



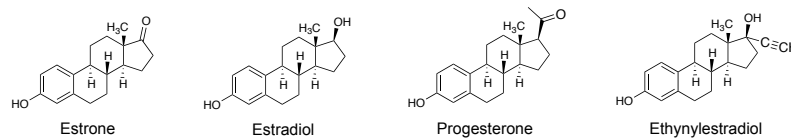
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24.15: Sex hormones - (please read)

Androgens: male (*slugs and snails, and puppy-dogs' tails*)

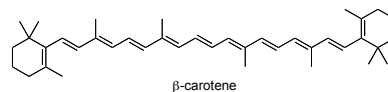
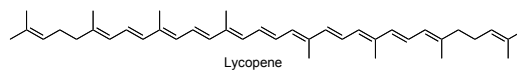


Estrogens: female (*sugar and spice and everything nice*)



24.16: Carotenoids - (please read)

derived from phytocene (C₄₀) (please read)



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