Biosynthesis pathways

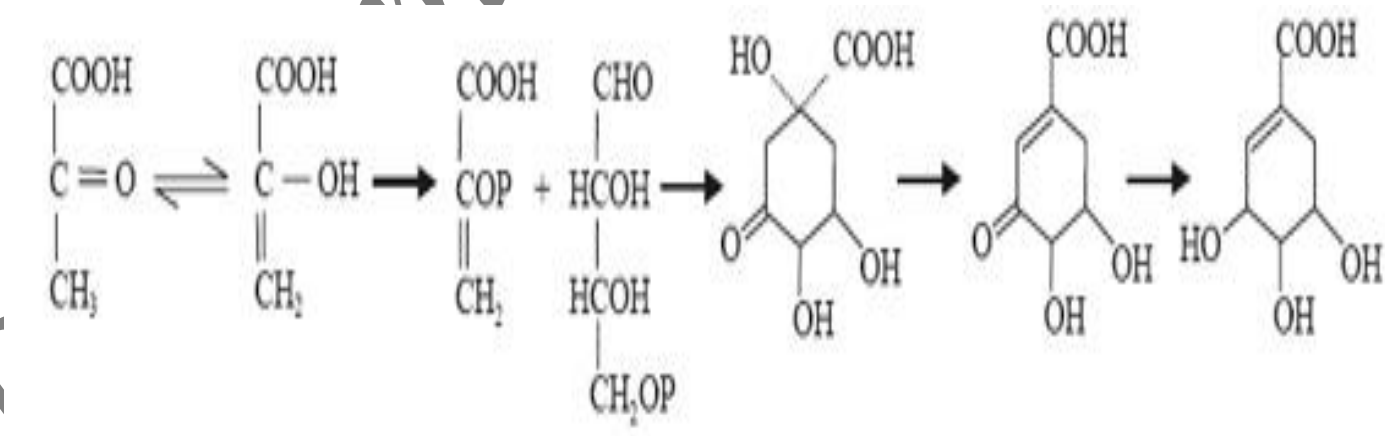
1. Biosynthesis of aromatic compounds: -

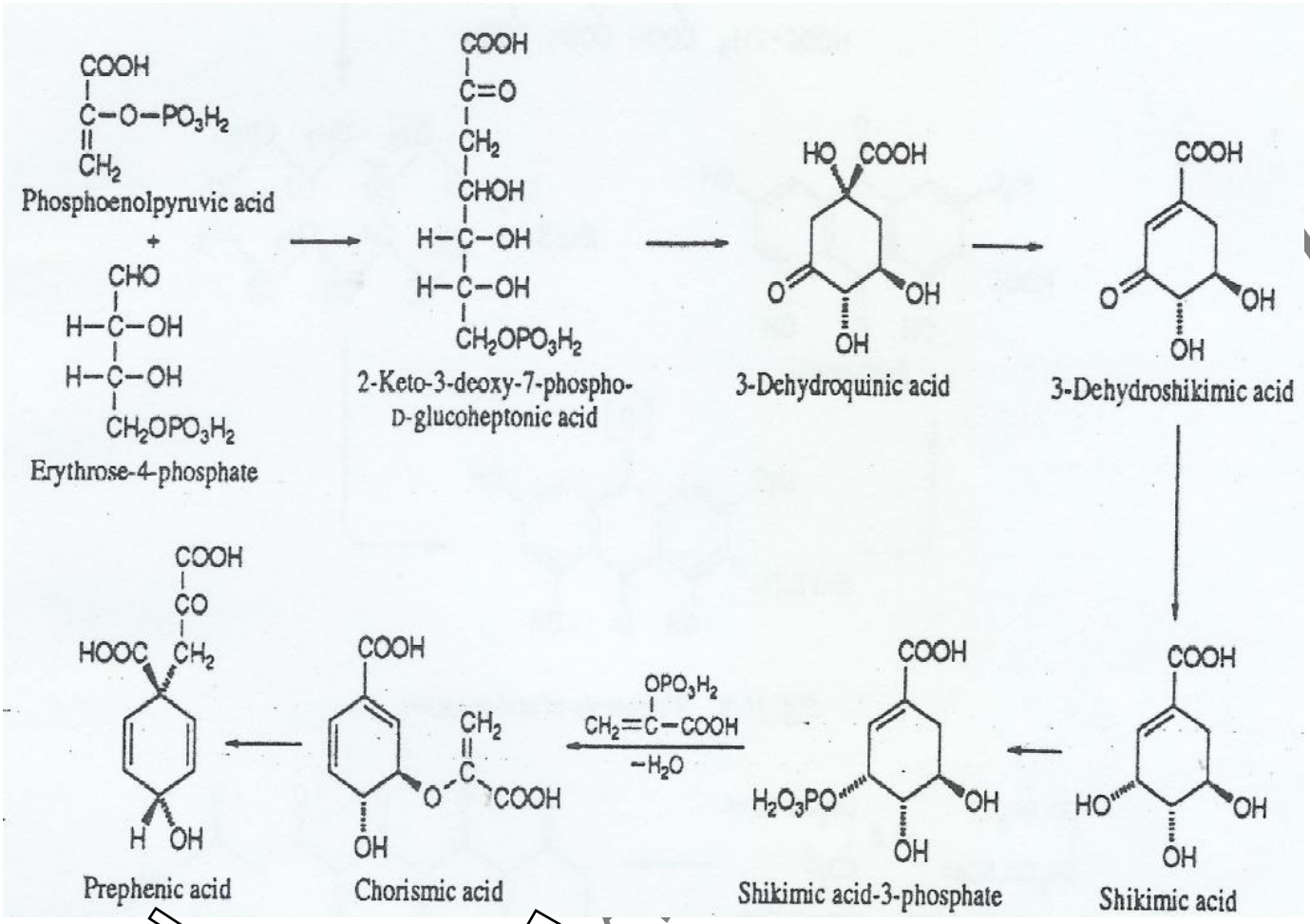
There are two pathways for the biosynthesis of aromatic compounds: -

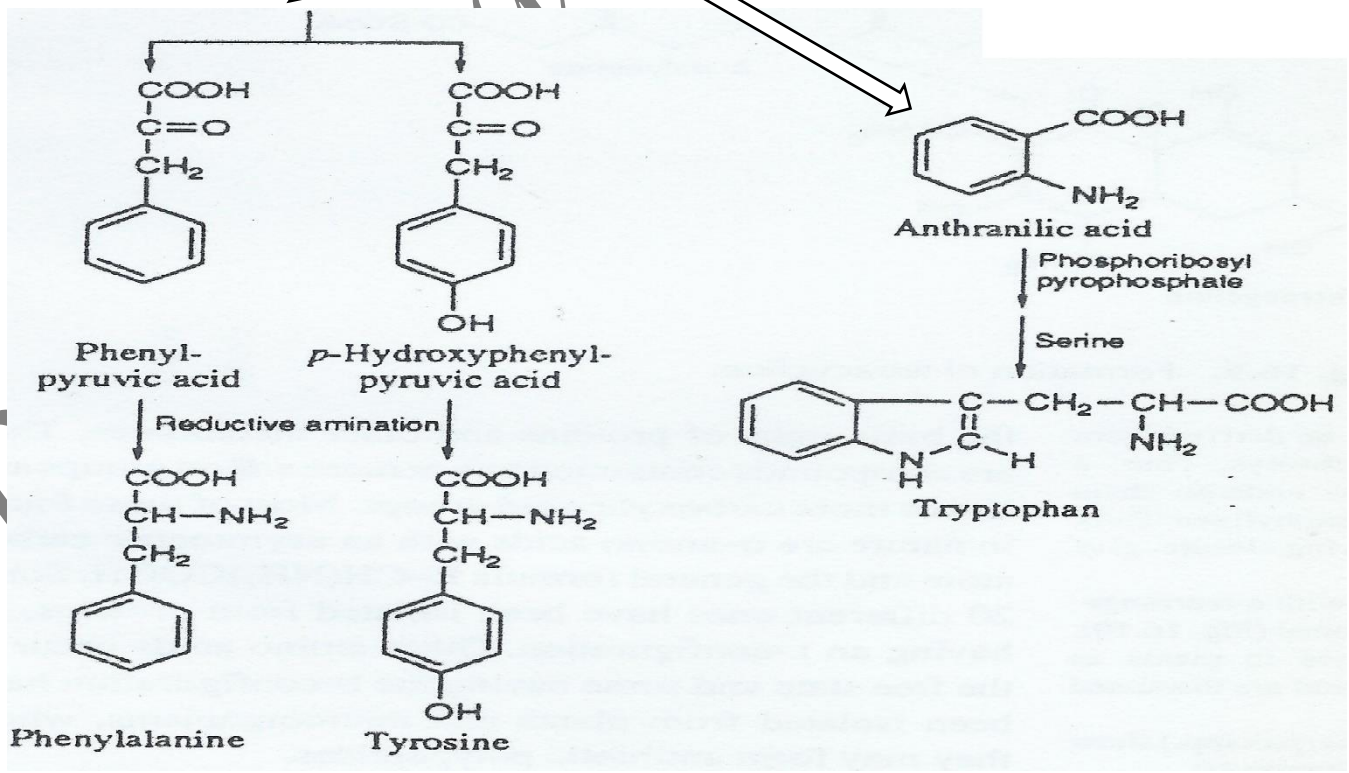
A. The shikimic acid pathway: - Shikimic acid is biosynthesized from:

phosphoenol pyruvic acid + erythrose-4-phosphate

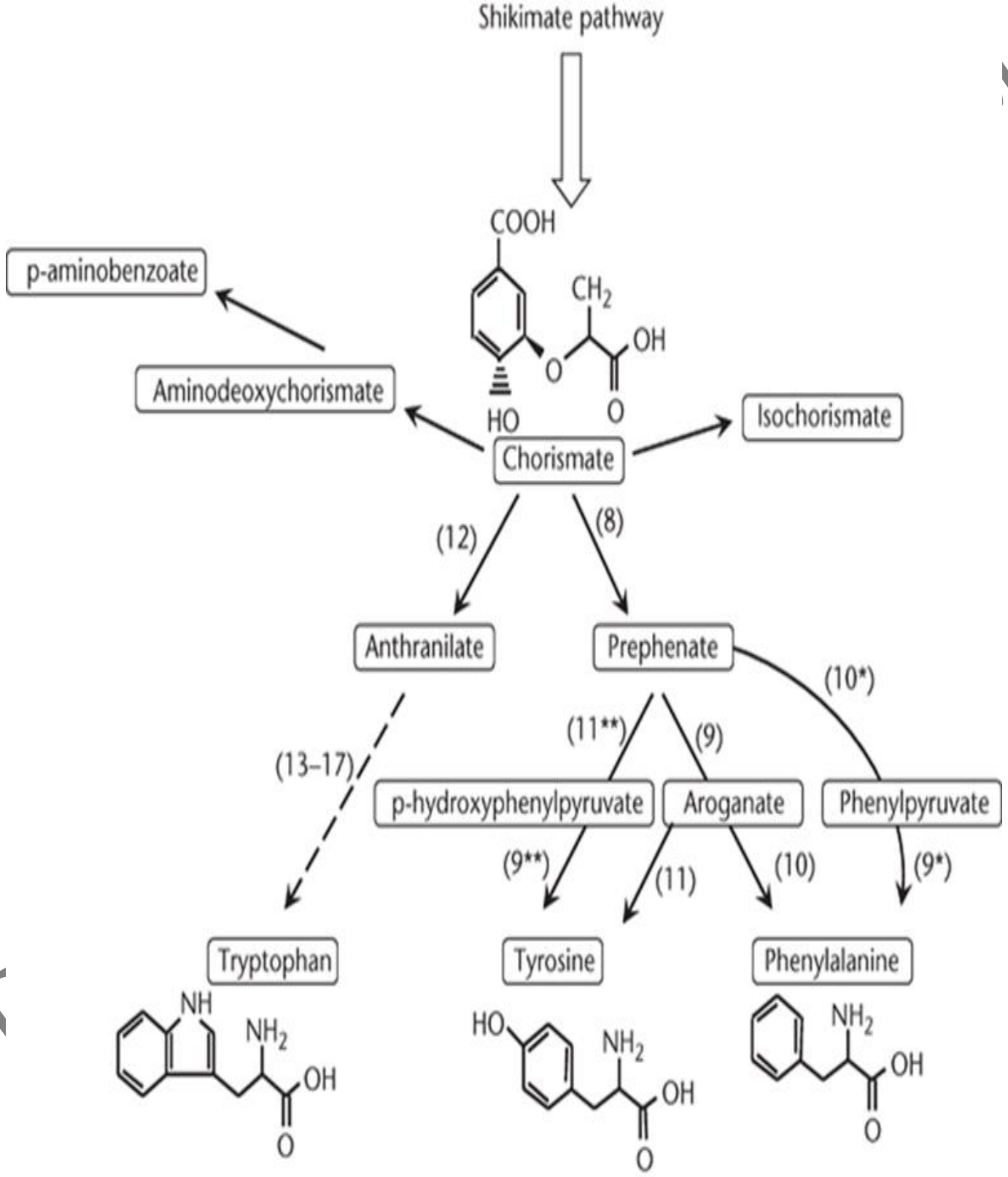
- shikimic acid undergo a series of phosphorylated intermediates yield chorismic acid which is an important branch – point intermediate.
- One branch leads two anthranilic acid then to tryptophan.
- The other leads to prephenic acid which is the last non aromatic compound in the sequences.
- Prephenic acid can be aromatized in two ways.
  - ✓ The first proceeds by dehydration and simultaneous decarboxylation to yield phenyl pyruvic acid, the direct precursor of phenyl alanine.
  - ✓ The second occurs by dehydrogenation and decarboxylation to give the P-hydroxy phenyl pyruvic acid, the precursor of tyrosine.



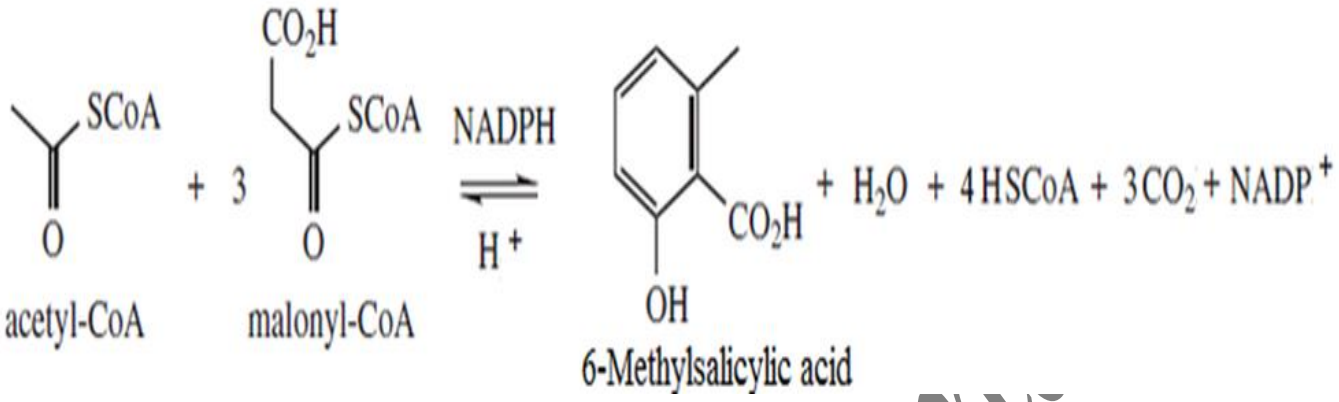

Phosphoenolpyruvic acid
Erythrose-4-phosphate
2-Keto-3-deoxy-7-phospho-D-glucoheptonic acid
3-Dehydroquinic acid
3-Dehydroshikimic acid
Shikimic acid
Shikimic acid-3-phosphate
Chorismic acid
Prephenic acid


Phenyl-pyruvic acid
p-Hydroxyphenyl-pyruvic acid
Reductive amination
Phenylalanine
Tyrosine
Anthranilic acid
Phosphoribosyl pyrophosphate
Serine
Tryptophan

Shikimate pathway for the biosynthesis of aromatic & phenolic compounds



B. The acetate hypothesis: - 4 acetate groups when linked together they give rise to the formation of 6-methyl salicylic acid. This was found when using labeled carbon in certain Penicillium species.



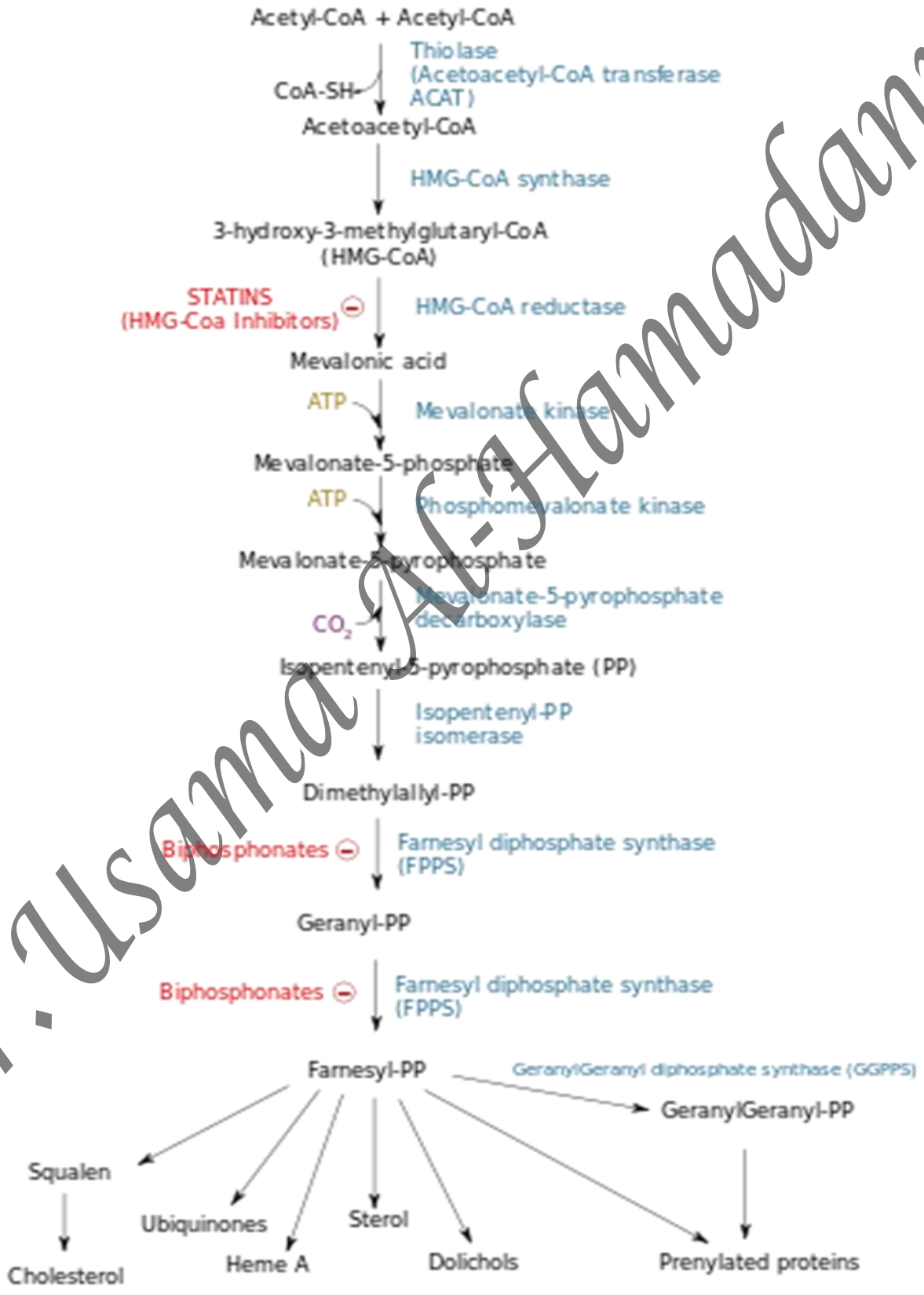
Biosynthesis of non-aromatic compounds (acetate-mevalonate) pathway

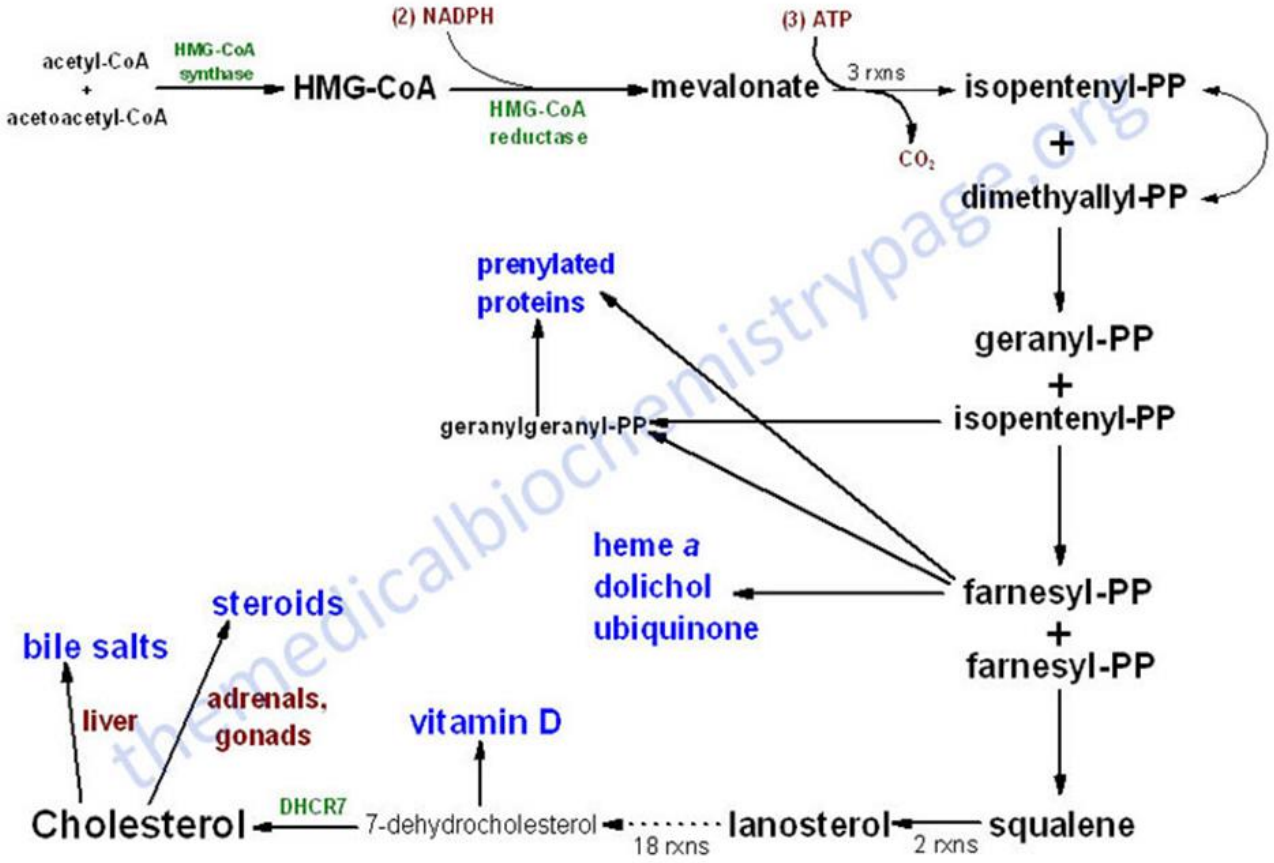
Three molecules of acetyl-coenzyme A are used to form mevalonic acid (MVA). Two molecules combine initially in a Claisen condensation to give acetoacetyl-CoA, & a third is incorporated via a stereo specific aldol addition giving the branched-chain ester β-hydroxy-β-methyl glutaryl- CoA (HMG-CoA). The conversion of HMG-CoA into MVA involve a two-step reduction. The six-carbon compound MVA is transformed into the five-carbon phosphorylated isoprene units in a series of reactions involving decarboxylation/dehydration to give isopentenyl pyro phosphate (IPP).

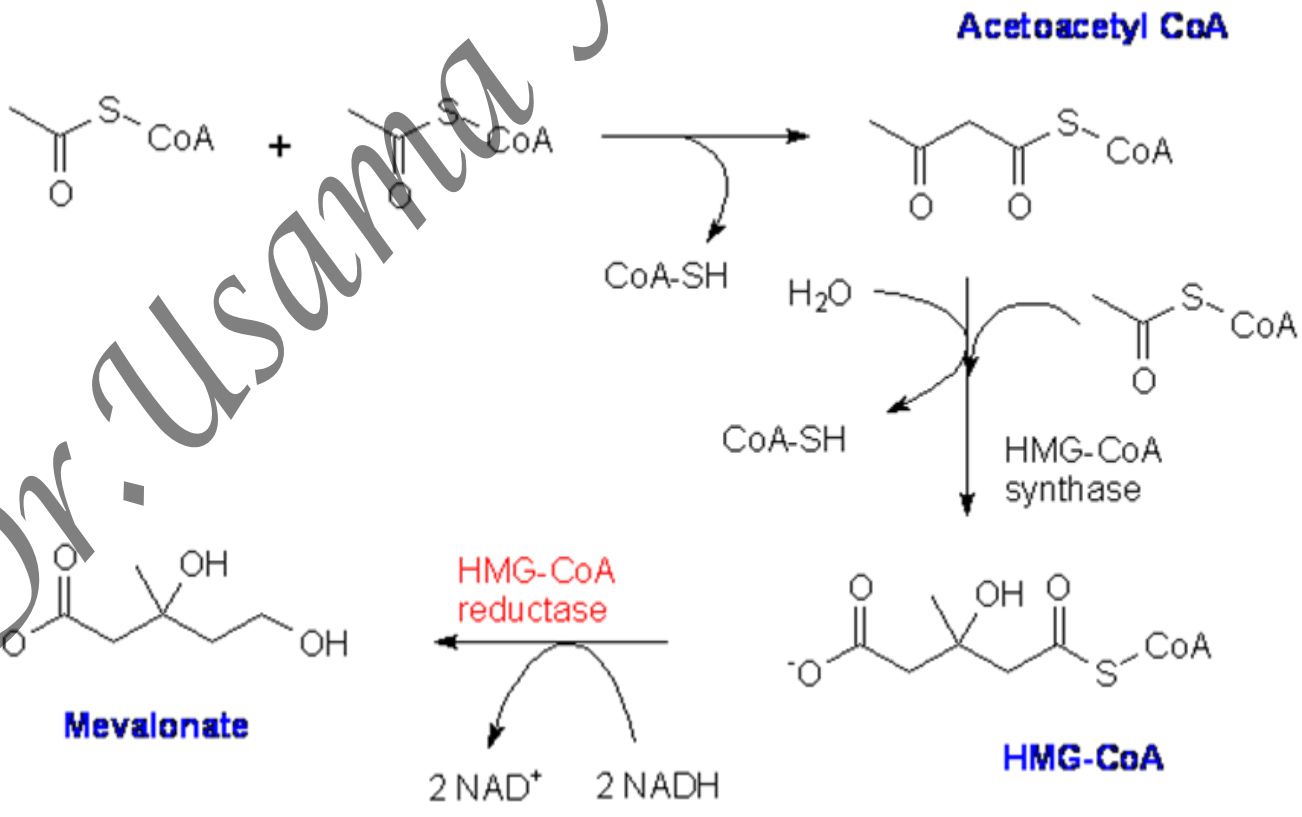
C_5 isoprene units give rise a large structurally diverse family of natural products named terpenoids when these C_5 isoprene units joined together in a head-to-tail fashion. Typical structures contain carbon skeletons represented by $(C_5)_n$, & are classified as hemiterpenes **(C_5)**, monoterpenes **(C_{10})**, sesquiterpenes **(C_{15})**, diterpenes **(C_{20})**, sesterterpenes **(C_{25})**, triterpenes **(C_{30})** & tetraterpenes **(C_{40})**.

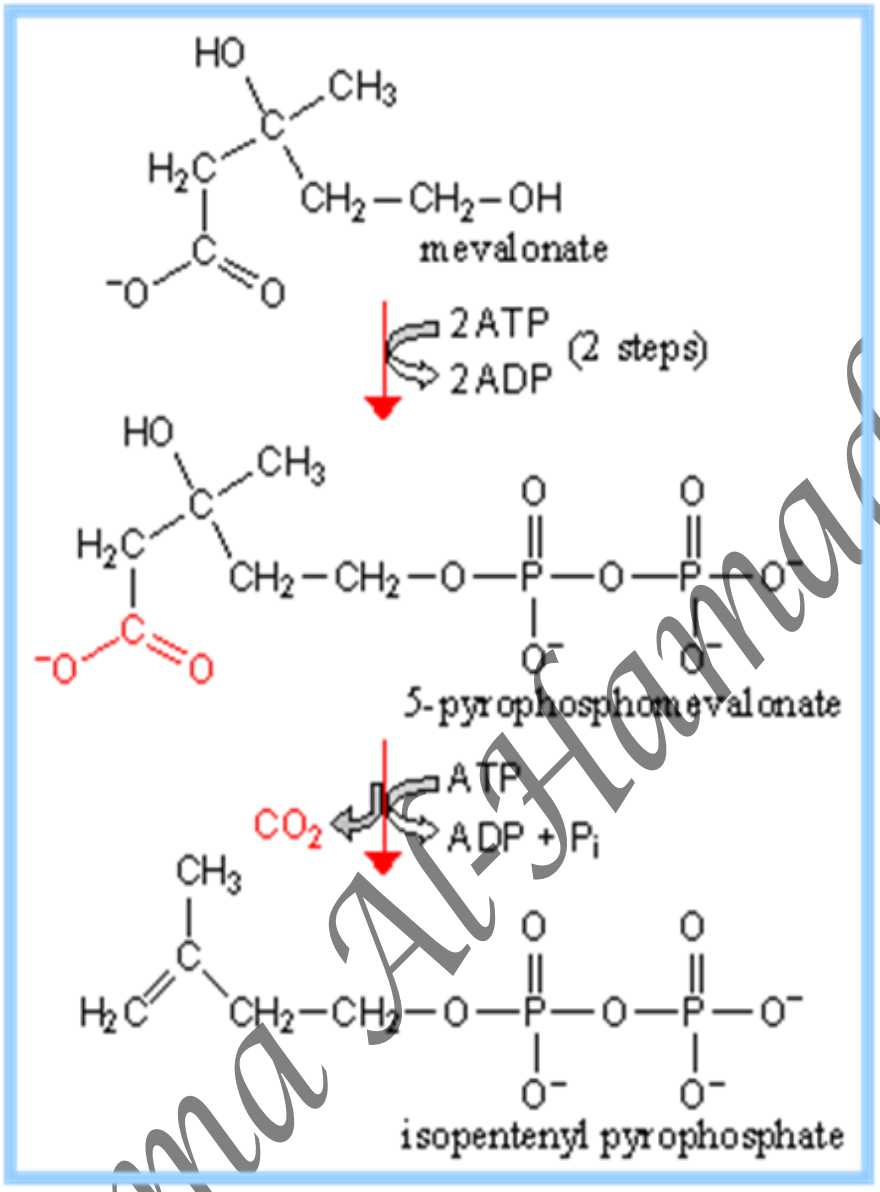
Isoprene is produced naturally & the biochemically active isoprene units were identified as the diphosphate (pyrophosphate) esters **dimethyl allyl pyrophosphate (DMAPP)** & **isopentenyl pyrophosphate (IPP).** Relatively few of the natural terpenoids conform exactly to the simple concept of a linear head-to-tail combination of isoprene are seen with geranyl **(C_{10}),** farnesyl **(C_{15}),** geranyl-geranyl **(C_{20}),** squalene **(C_{30}),** phytoene **(C_{40}).**

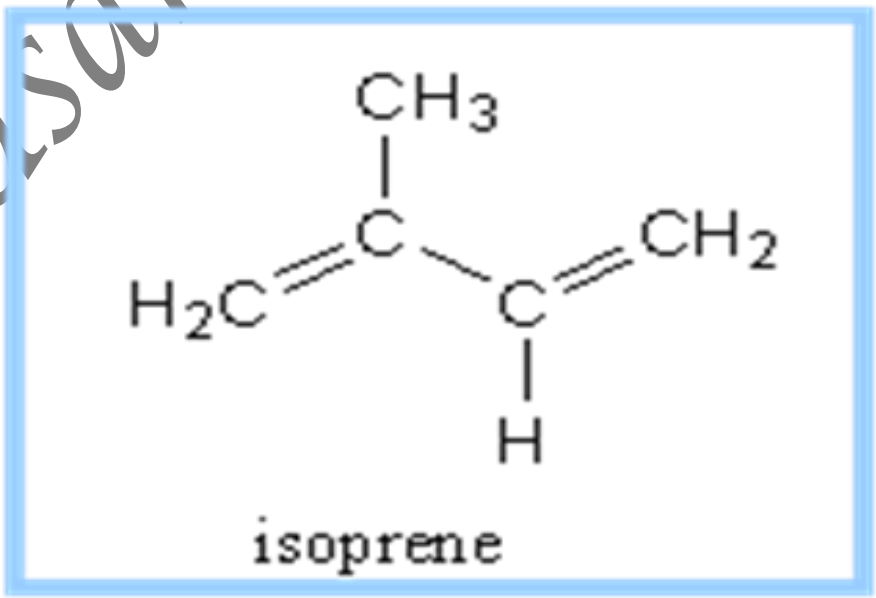
Mevalonate pathway

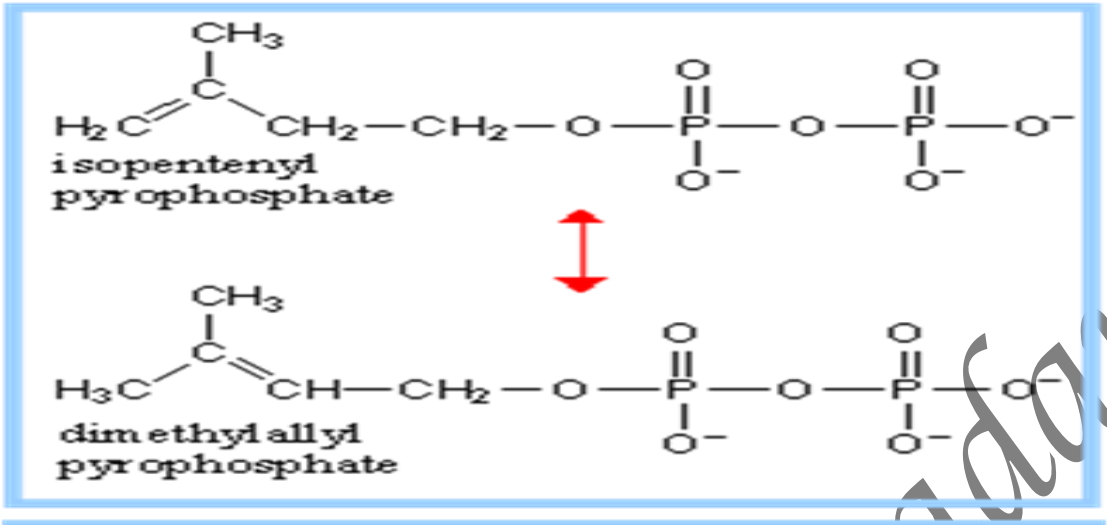


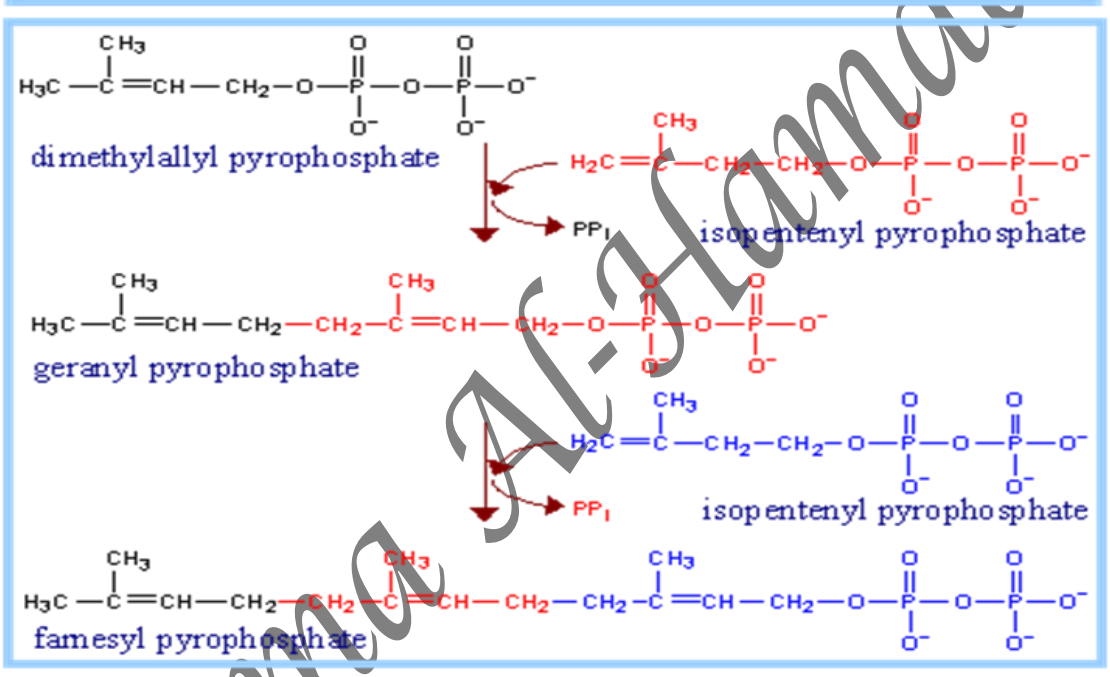


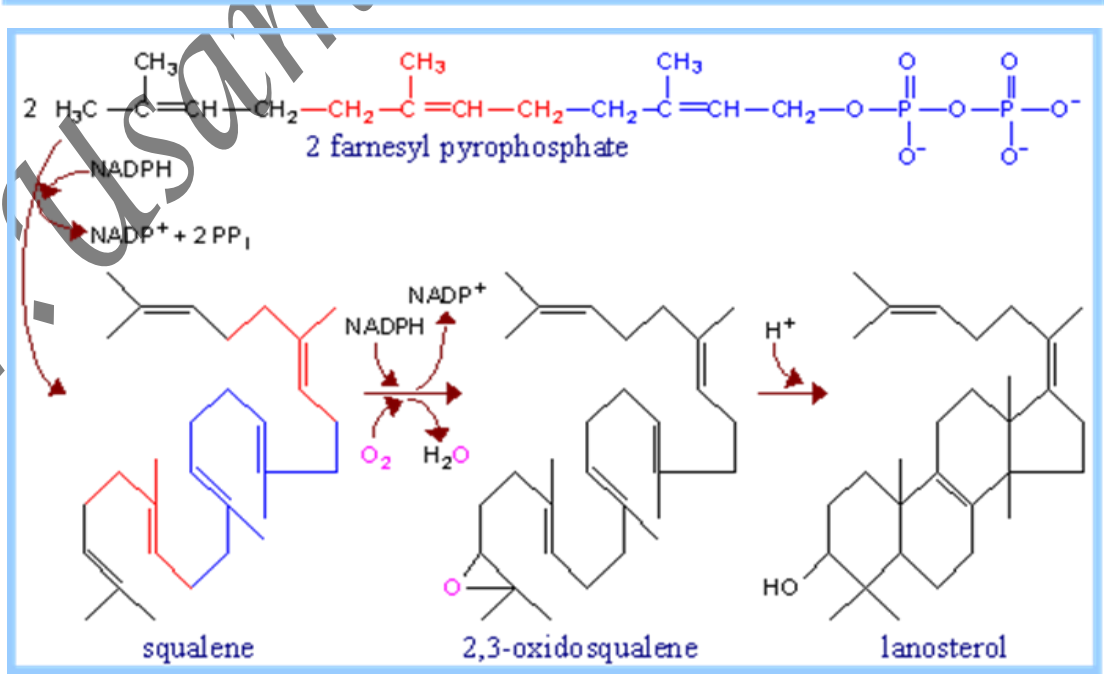












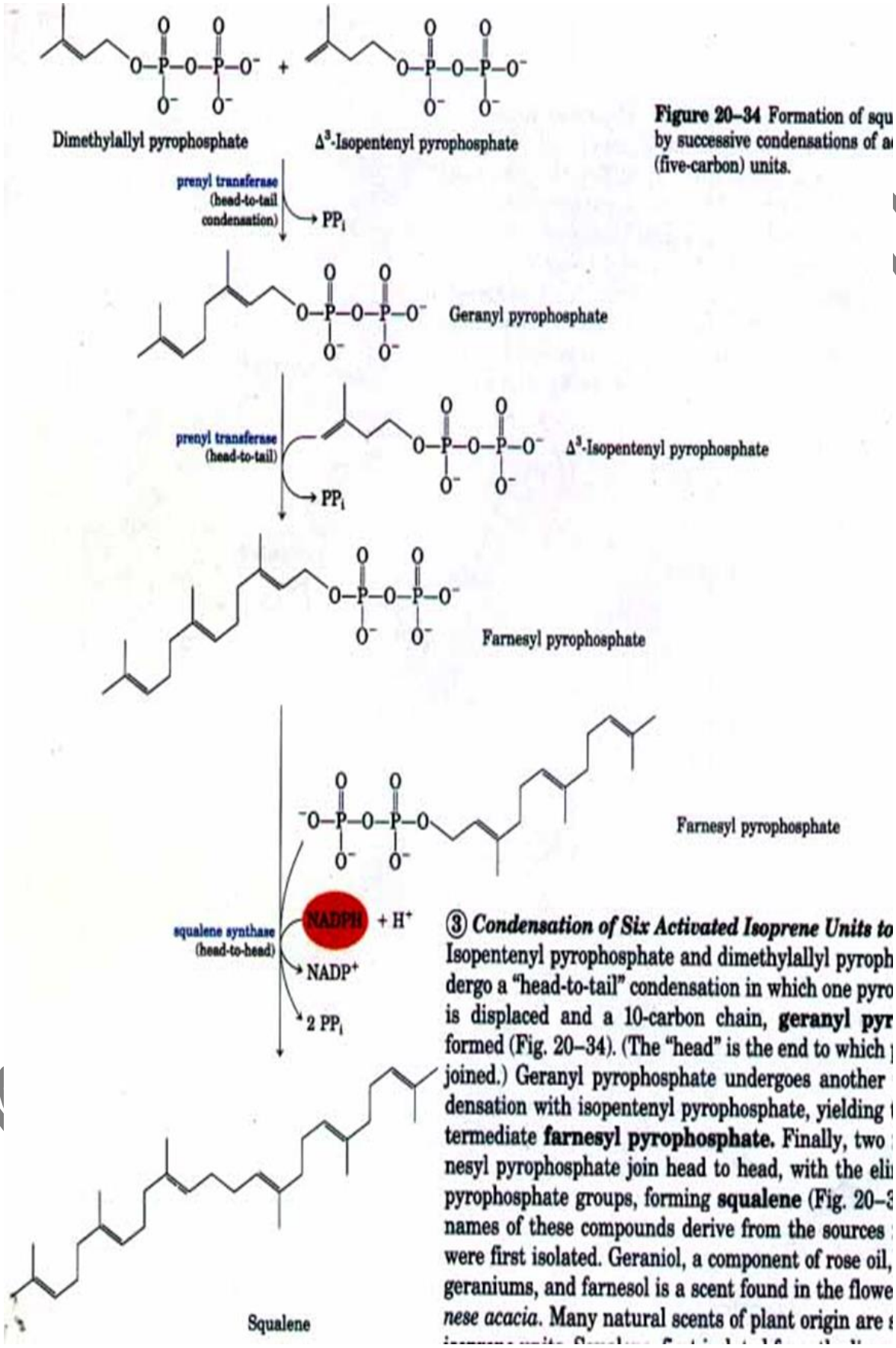


Figure 20–34 Formation of squ
by successive condensations of a
(five-carbon) units.

③ ***Condensation of Six Activated Isoprene Units to***
Isopentenyl pyrophosphate and dimethylallyl pyroph
dergo a "head-to-tail" condensation in which one pyro
is displaced and a 10-carbon chain, **geranyl pyr**
formed (Fig. 20–34). (The "head" is the end to which
joined.) Geranyl pyrophosphate undergoes another
densation with isopentenyl pyrophosphate, yielding
termediate **farnesyl pyrophosphate.** Finally, two
nesyl pyrophosphate join head to head, with the eli
pyrophosphate groups, forming **squalene** (Fig. 20–3
names of these compounds derive from the sources
were first isolated. Geraniol, a component of rose oil,
geraniums, and farnesol is a scent found in the flowe
nese acacia. Many natural scents of plant origin are