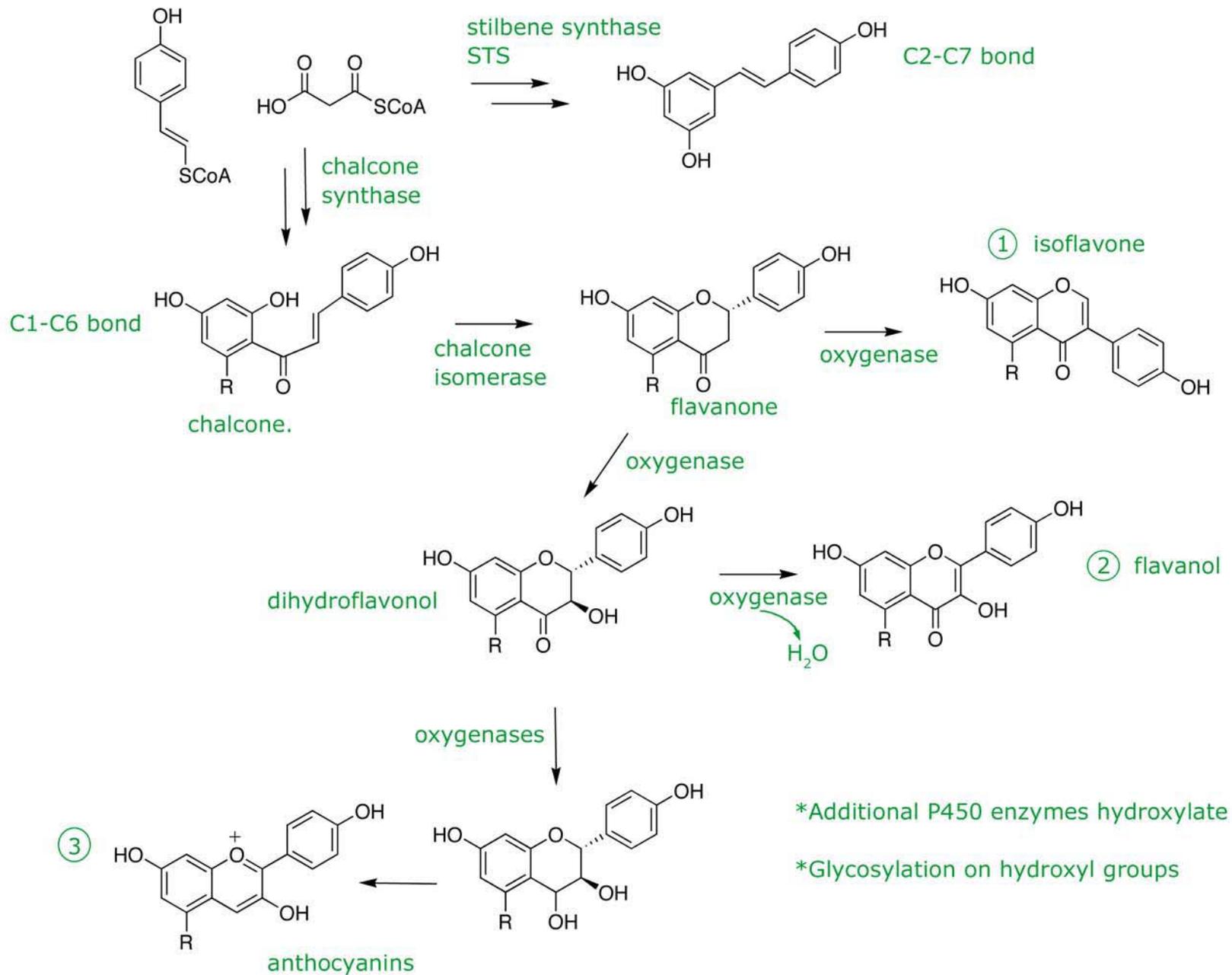


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 Shikimate Pathway
 Flavonoid Biosynthesis Review

TE activity in stilbene synthase.



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Alkaloid Biosynthesis:

Nitrogen containing compounds

Starting materials:

Amino acids and nucleic acids

Amino Acids:

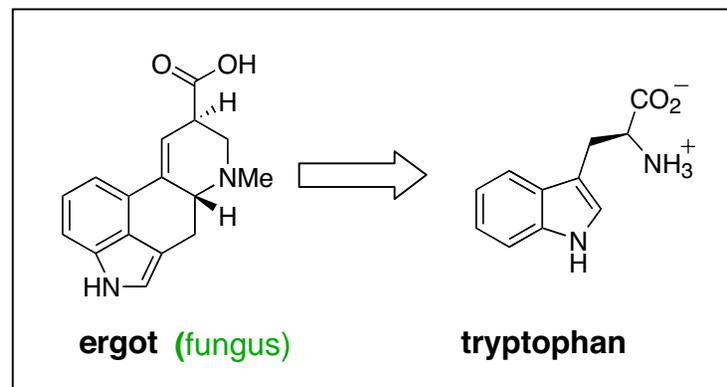
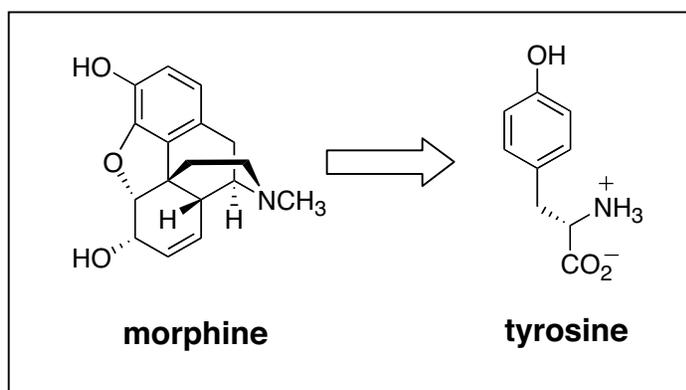
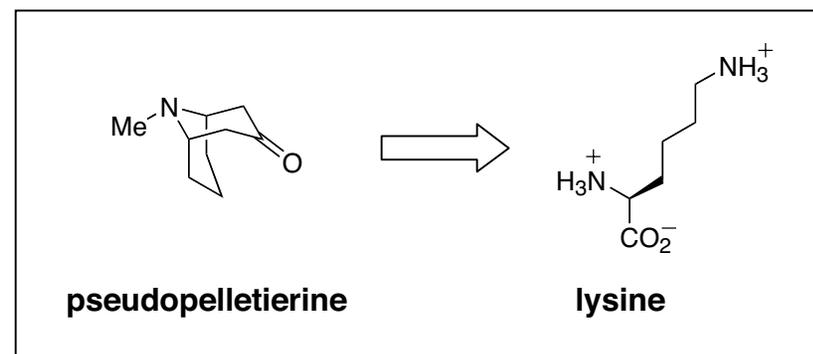
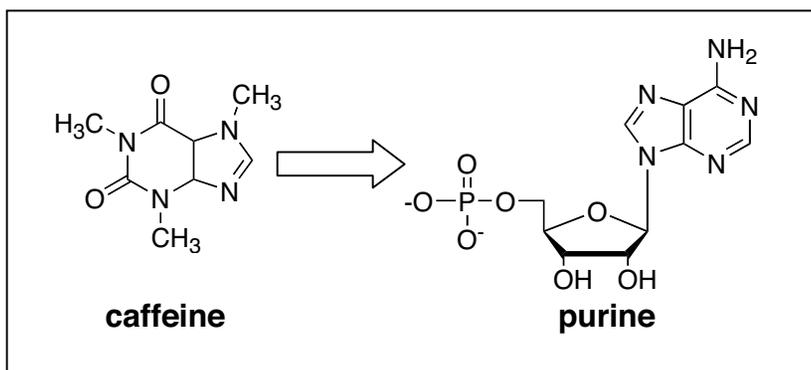
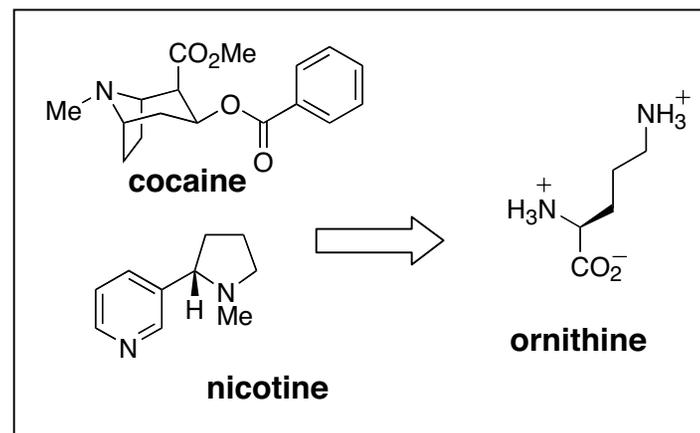
Ornithine

Lysine

Tyrosine

Tryptophan

Purine



rebeccamycin
staurosporine

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Alkaloid Biosynthesis:

Purine Derived Products: Caffeine

Figure removed due to copyright reasons.
Please see Figure 4 in *Trends Plant Sci* 6 (2001): 407.

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Alkaloid Biosynthesis:

Purine Derived Products: Caffeine

Genetically engineered decaf coffee

70% reduction in caffeine content by using RNAi of theobromine synthase

otherwise normal phenotype

Nature (2003) 423, 823

Recently discovered natural variant deficient in caffeine synthase

Nature (2004) 429, 826.

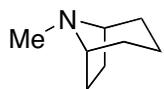
Promoter of the 3 methyl transferases recently discovered

J. Biotech. (2005) 119, 20-25.

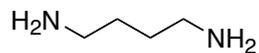
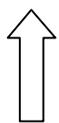
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Alkaloid Biosynthesis:

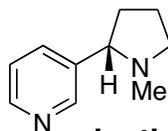
Ornithine and Lysine Derived Products



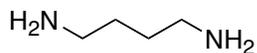
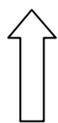
tropanes



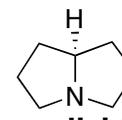
**putrescine (via ornithine)
2 acetates**



nicotine



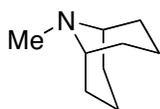
**putrescine (via ornithine)
nicotinic acid**



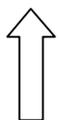
pyrrolizidine



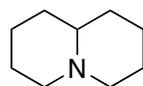
**homospermidine
(via 2 putrescines)**



pseudopelletierine



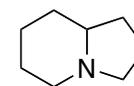
**cadaverine (via lysine)
2 acetates**



quinolizidines



2 cadaverines



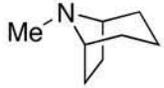
indolizidines



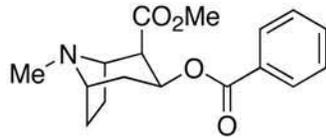
**pipecolic acid (via lysine)
1 acetate**

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Alkaloid Biosynthesis:
Ornithine Derived Products



tropanes

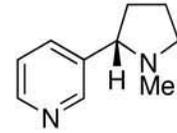


cocaine

Pyrrolidine Alkaloids



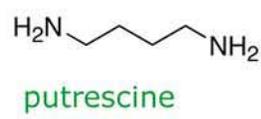
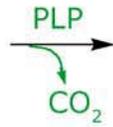
pyrrolidines



nicotine

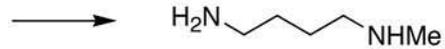


ornithine



putrescine

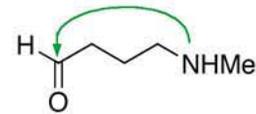
N-Me transferase



trans-amination

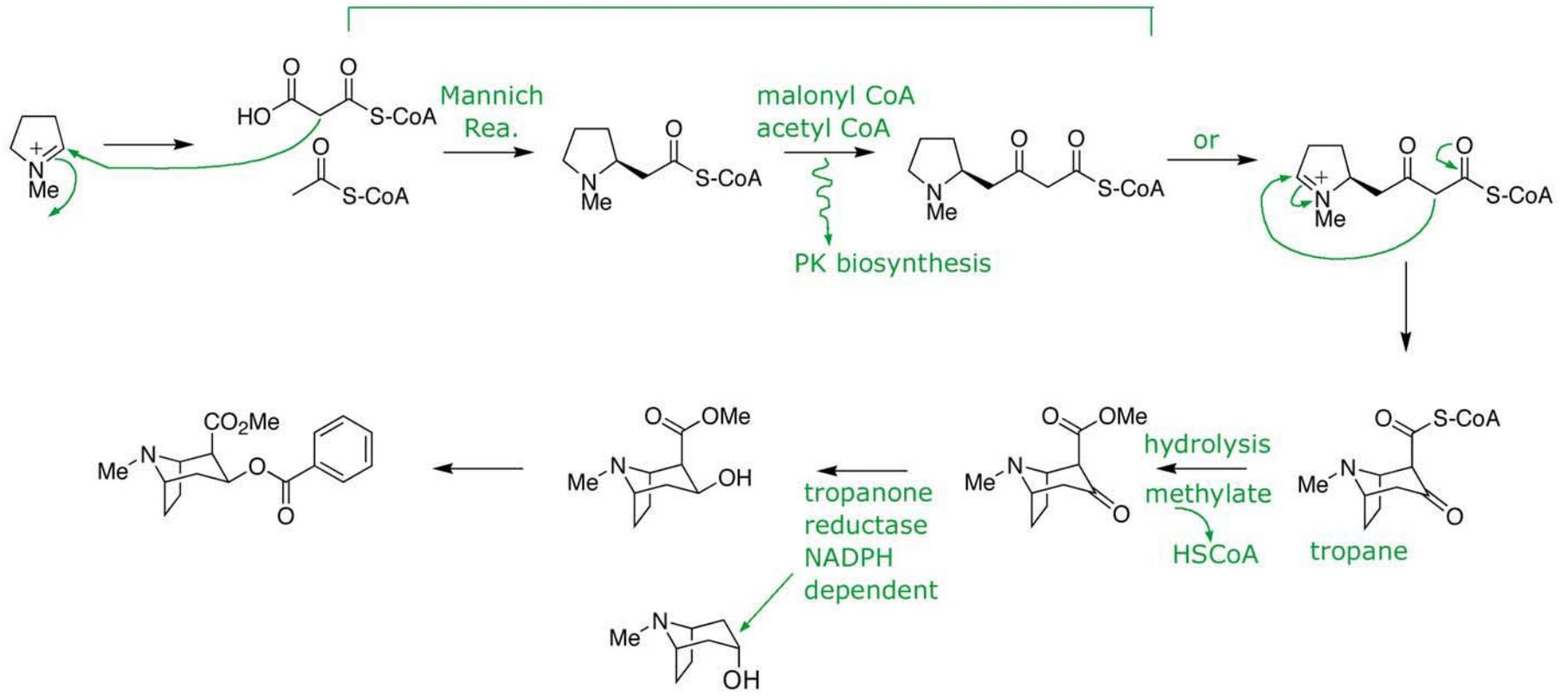


(imine)
iminium ion.



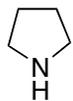
5.451 F2005
Alkaloid Biosynthesis:
Ornithine Derived Products
Cocaine

stepwise? acetate chain may be preformed

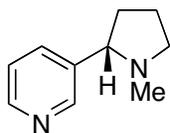


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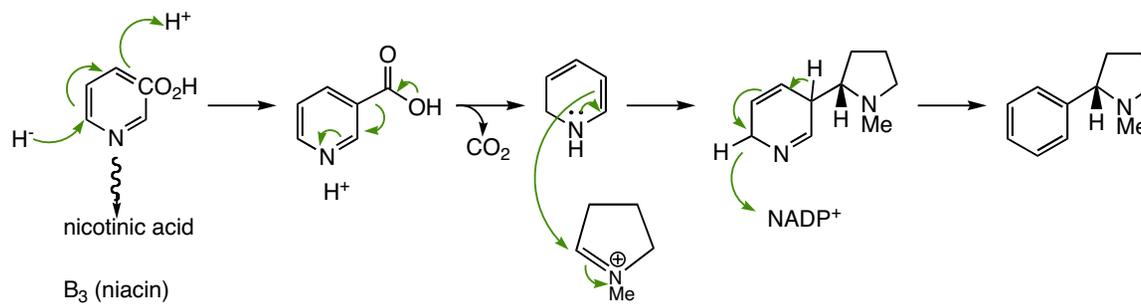
Alkaloid Biosynthesis:
Ornithine Derived Products



pyrrolidines

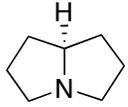


nicotine

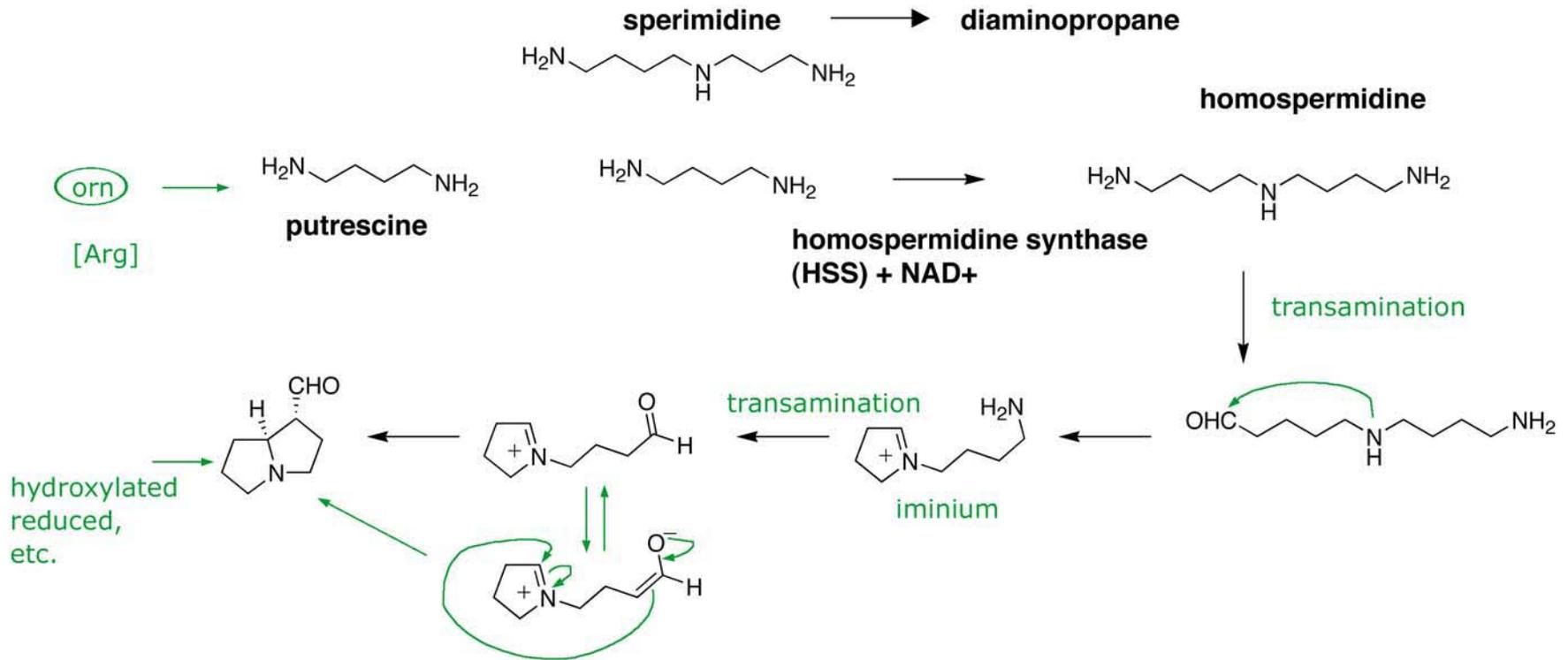


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Alkaloid Biosynthesis:
Ornithine Derived Products

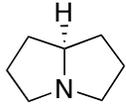


pyrrolizidine



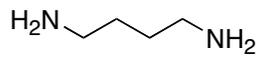
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**Alkaloid Biosynthesis:
Ornithine Derived Products**



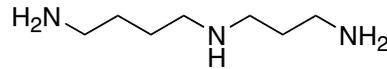
pyrrolizidine

**Origin of a secondary metabolic pathway?
Found only in angiosperms**



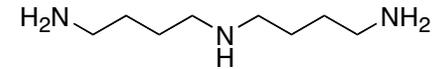
putrescine

+

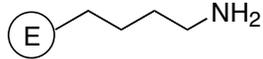


spermidine

HS synthase



homospermidine



E = eIF5A

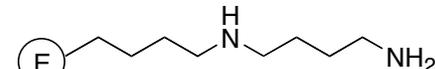
lysine of transcription factor

+

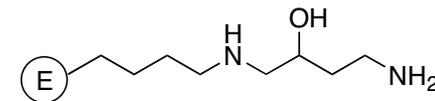


DH synthase

→
deoxyhypusine
synthase



deoxyhypusine

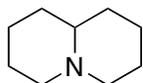


hypusine

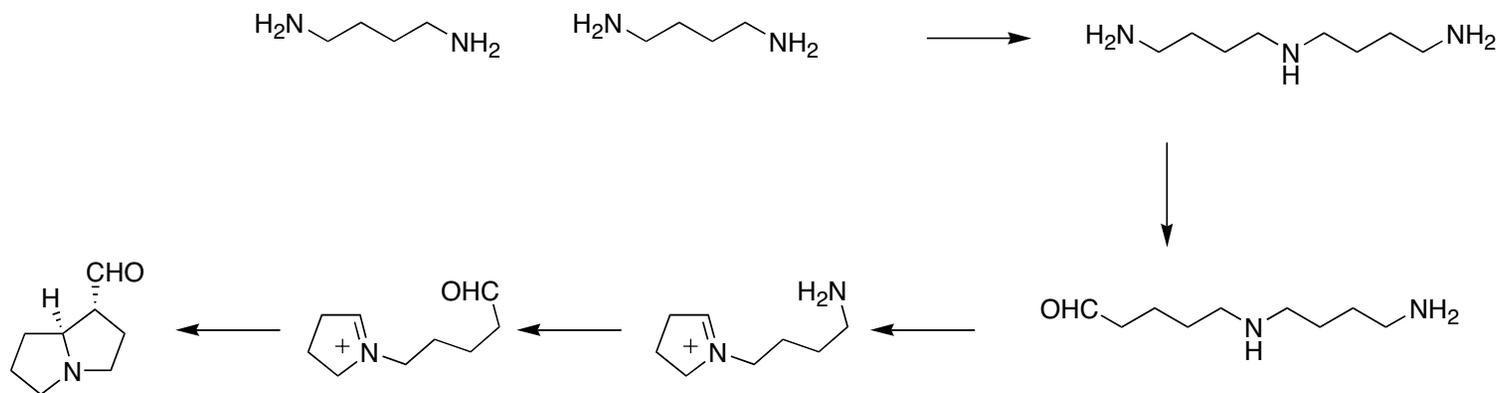
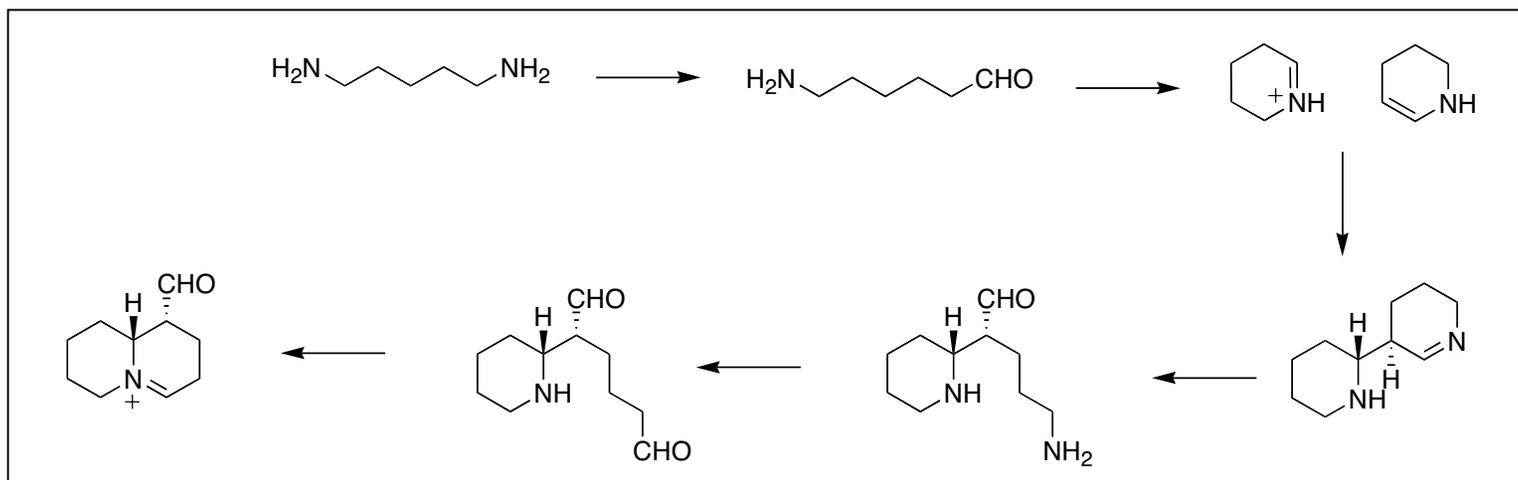
PNAS (1999) 96, p. 14779

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Alkaloid Biosynthesis:
Lysine Derived Products

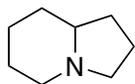


quinolizidines

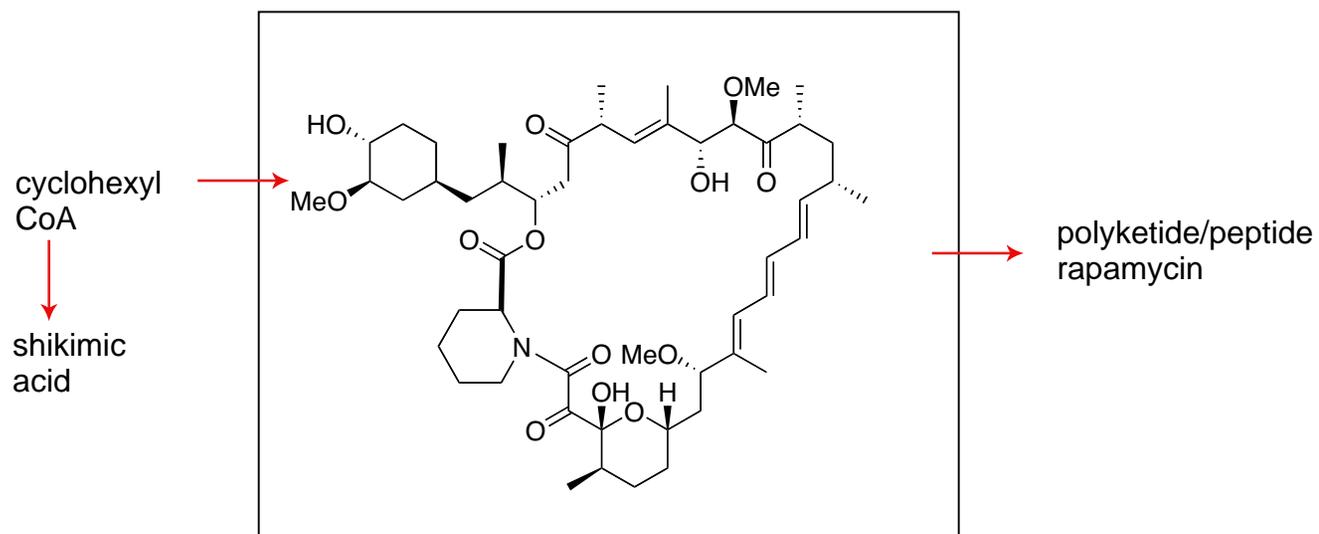
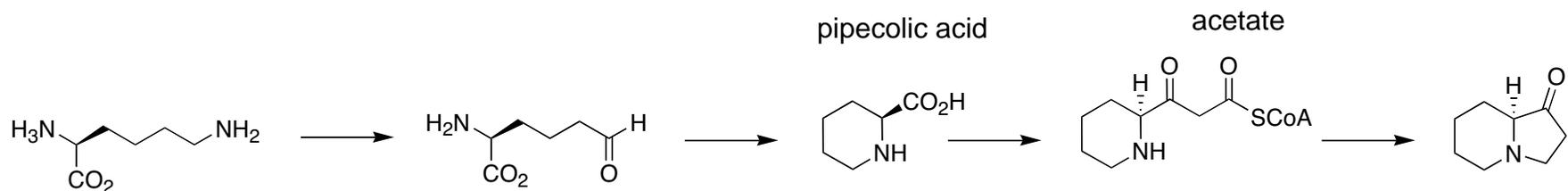


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**Alkaloid Biosynthesis:
Lysine Derived Products**



indolizidines



5.451 F2005

**Alkaloid Biosynthesis:
Ornithine Derived Products**

**Source of alkaloids
arthropod eats plant;
or ant or symbiont of ant makes alkaloid
vertebrate (frog) eats ant**

Figure removed due to copyright reasons.

alkaloids found in ants and frogs

See Figure 1 in *PNAS* 101 (2004): 8045.

Figure removed due to copyright reasons.

after injection, can be derivatized by frog to make more poisonous

See Figure 1 in *PNAS* 100 (2003): 11092.

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Alkaloid Biosynthesis:
Ornithine Derived Products
Chemical Defense

Figures removed due to copyright reasons.

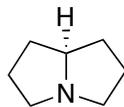
5.451 F2005

**Alkaloid Biosynthesis:
Ornithine Derived Products**

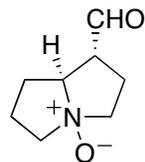
Removed due to copyright reasons.

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**Alkaloid Biosynthesis:
Ornithine Derived Products
Outwitting the Chemical Defense-
Detoxification by oxidation**



pyrrolizidine



detoxification

Figure removed due to copyright reasons.
Please see Figure 1 in *PNAS* 99 (2002): 6085.