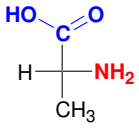
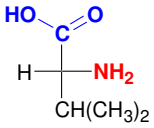
Solutions

25.1. In each case, the chirality center has the *R* configuration.

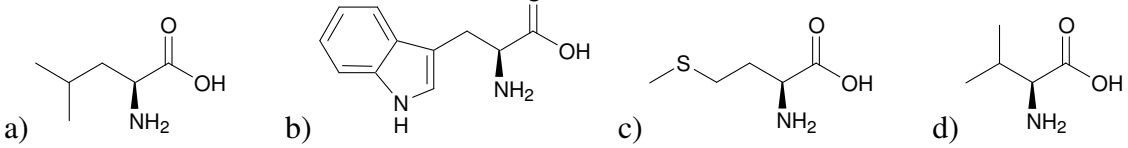


D-Alanine



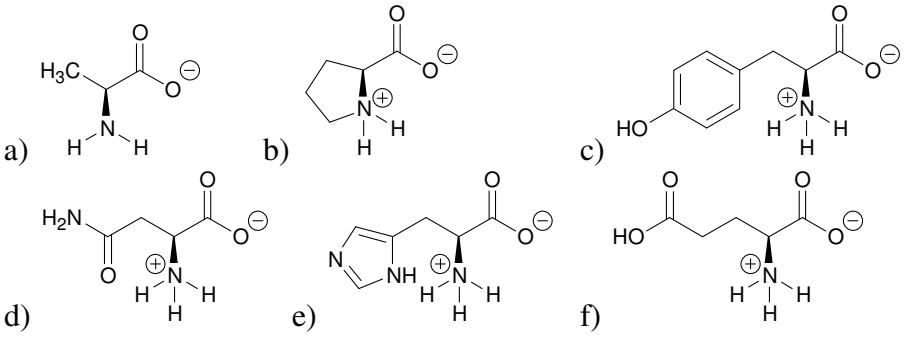
D-Valine

25.2.



25.3.
a) Pro, Phe, Trp, Tyr, and His
b) Phe, Trp, Tyr, and His
c) Arg, His, and Lys
d) Met and Cys
e) Asp and Glu
f) Pro, Trp, Asn, Gln, Ser, Thr, Tyr, Cys, Asp, Glu, Arg, His, and Lys

25.4.



25.5. Arginine has a basic side chain, while asparagine does not. At a pH of 11, arginine exists predominantly in a form in which the side chain is protonated. Therefore, it can serve as a proton donor.

25.6. Tyrosine possesses a phenolic proton which is more readily deprotonated because deprotonation forms a resonance-stabilized phenolate ion. In contrast, deprotonation of the OH group of serine gives an alkoxide ion that is not resonance-stabilized. As a result, the OH group of tyrosine is more acidic than the OH group of serine.

25.7.

a) 2.77 b) 5.98 c) 9.74 d) 6.30

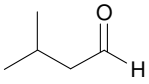
25.8.

a) aspartic acid
b) glutamic acid

25.9. Leucine and isoleucine

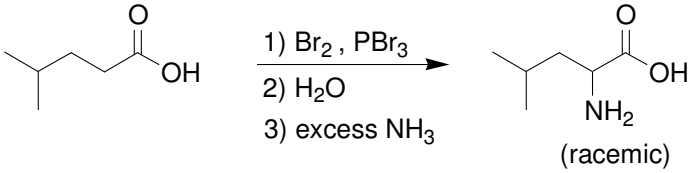
25.10. The pI of Phe = 5.48, the pI of Trp = 6.11, and the pI of Leu = 6.00.
a) At pH = 6.0, Phe will travel the farthest distance.
b) At pH = 5.0, Trp will travel the farthest distance.

25.11.



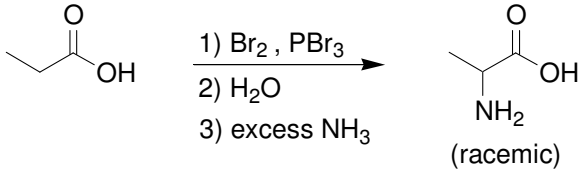
25.12.

a)



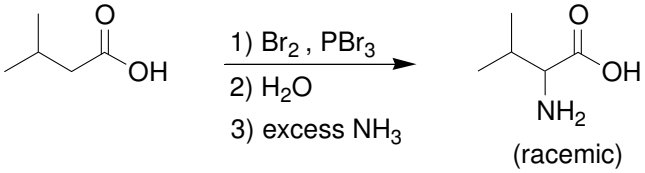
(racemic)

b)



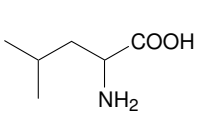
(racemic)

c)

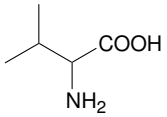


(racemic)

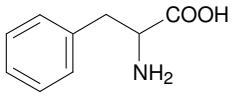
25.13.



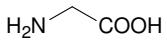
a) Leucine



b) Valine

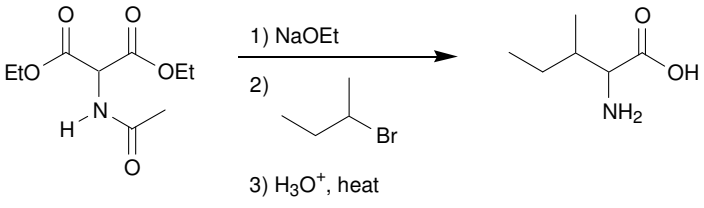


c) Phenylalanine

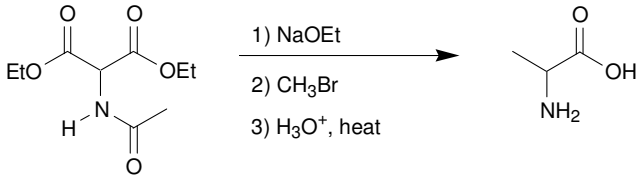


d) Glycine

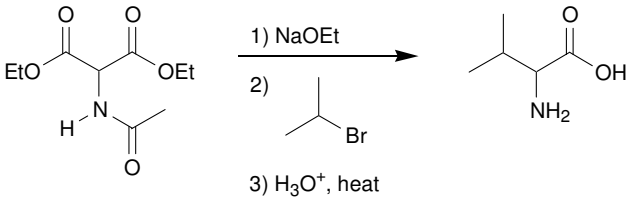
25.14.



a)

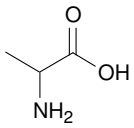


b)

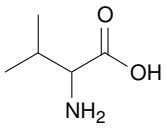


c)

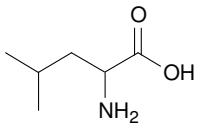
25.15.



a) **alanine**



b) **valine**

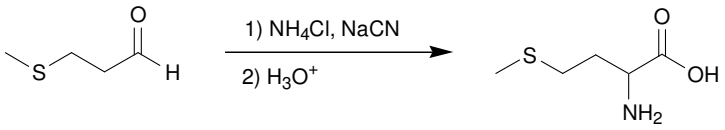


c) **leucine**

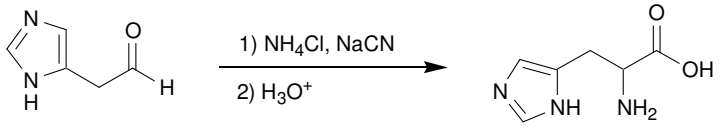
25.16. Leucine can be prepared via the amidomalonate synthesis with higher yields than isoleucine, because the former requires an S_N2 reaction with a primary alkyl halide, while the latter requires an S_N2 reaction with a secondary (more hindered) alkyl halide.

25.17.

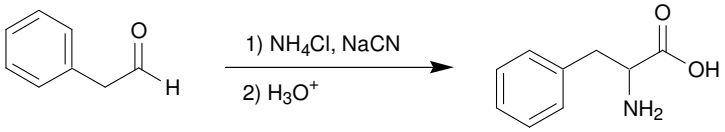
a)



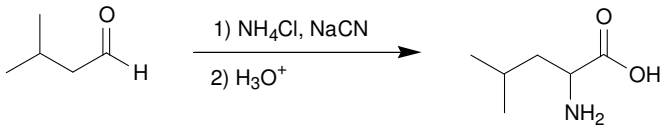
b)



c)

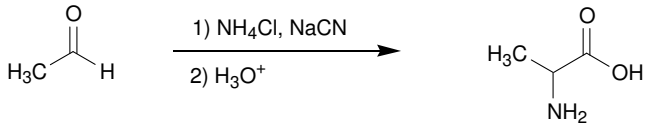


d)



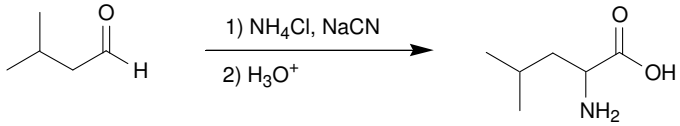
25.18.

a)



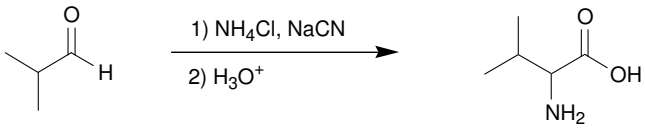
alanine

b)



leucine

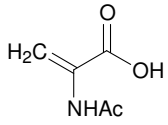
c)



valine

25.19.

a)



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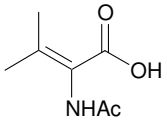

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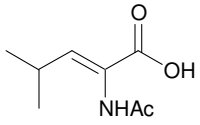

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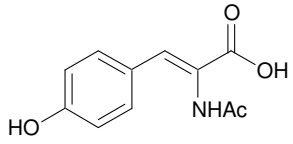
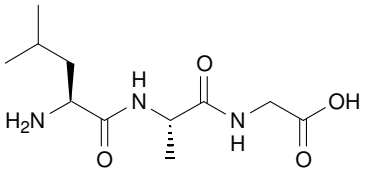


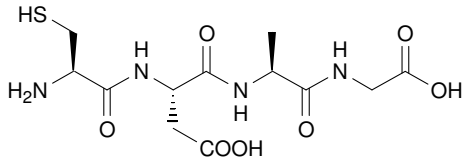
25.20. Glycine does not possess a chirality center, so the use of a chiral catalyst is unnecessary. Also, there is no alkene that would lead to glycine upon hydrogenation.

25.21.

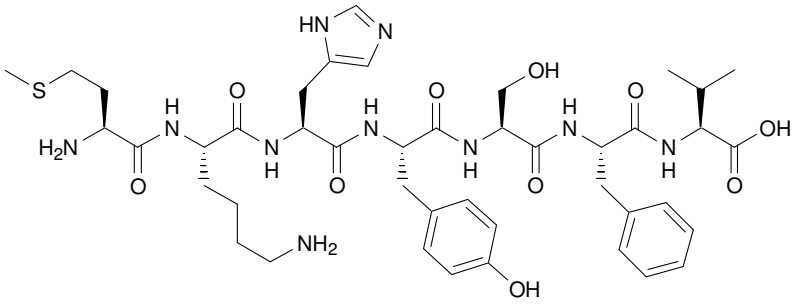
a)



b)



c)

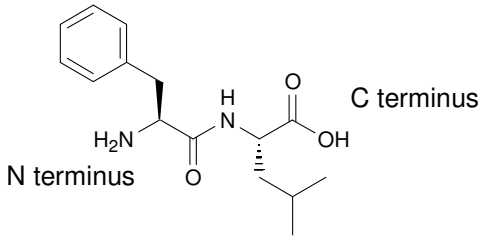


25.22. Leu-Ala-Phe-Cys-Asp or L-A-F-C-D.

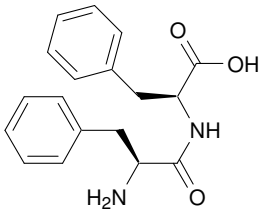
25.23. Cys-Tyr-Leu

25.24. Constitutional isomers

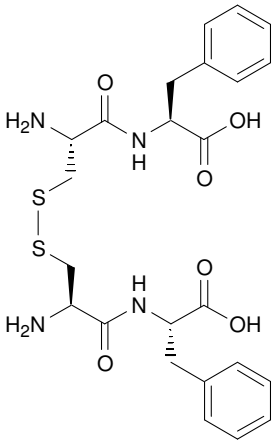
25.25.



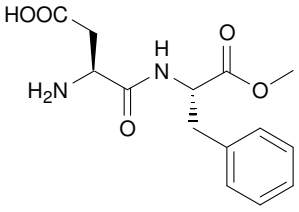
25.26. Steric hindrance results from the phenyl groups:



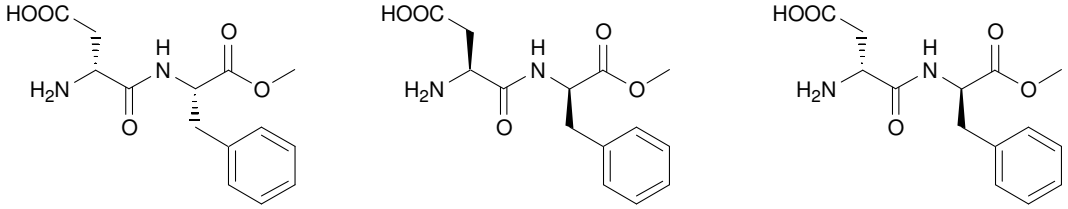
25.27.



25.28.

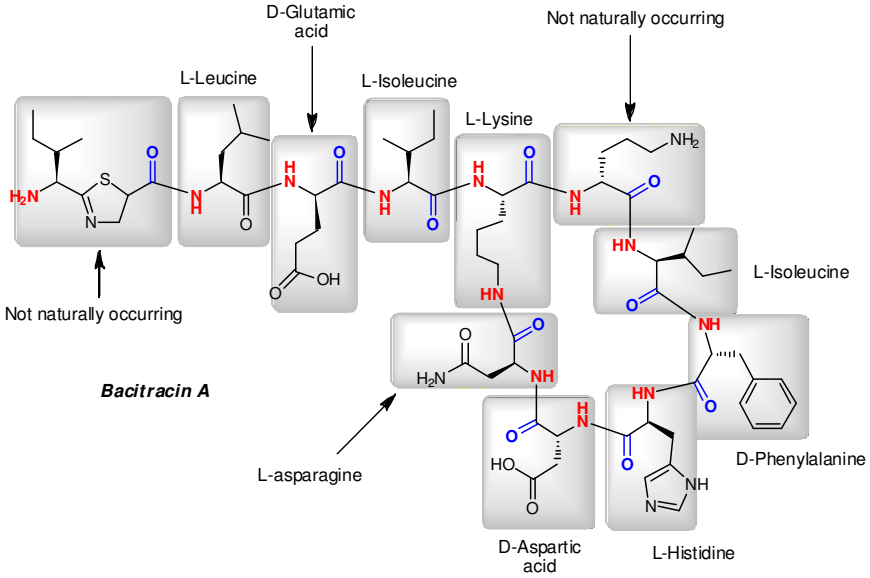


a)

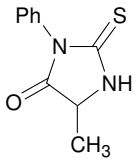


b)

25.29.



25.30. An Edman degradation will remove the amino acid residue at the N terminus, and Ala is the N terminus in Ala-Phe-Val. Therefore, alanine is removed, giving the following PTH derivative:

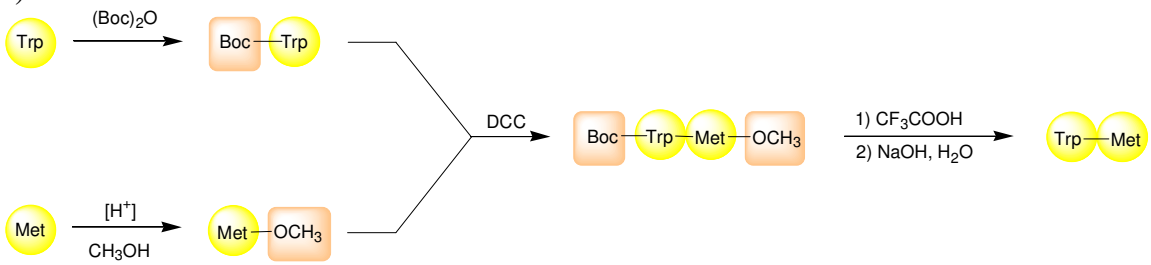


25.31.
Met-Phe-Val-Ala-Tyr-Lys-Pro-Val-Ile-Leu-Arg-Trp-His-Phe-Met-Cys-Arg-Gly-Pro-Phe-Ala-Val

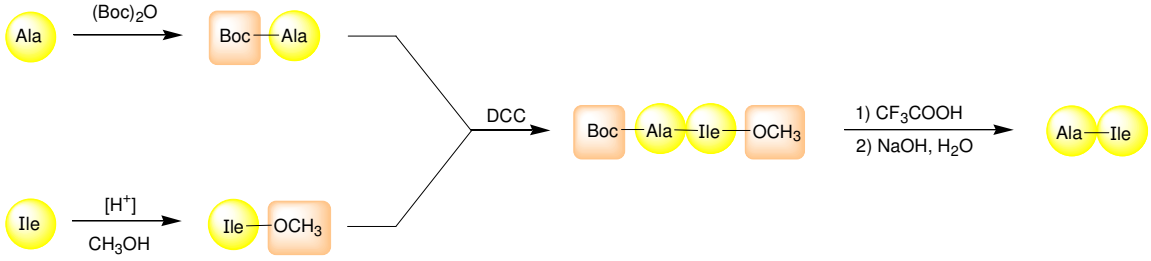
25.32. Ala-Phe-Val-Lys

25.33. Cleavage with trypsin will produce Phe-Arg, while cleavage with chymotrypsin will produce Arg-Phe. These dipeptides are not the same. They are constitutional isomers.

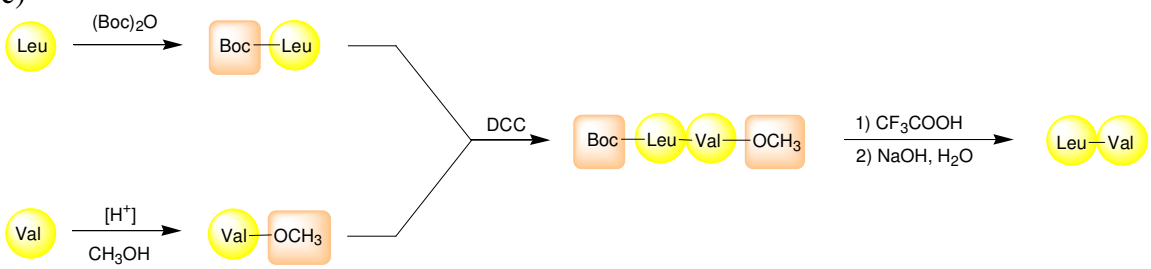
25.34.
a)



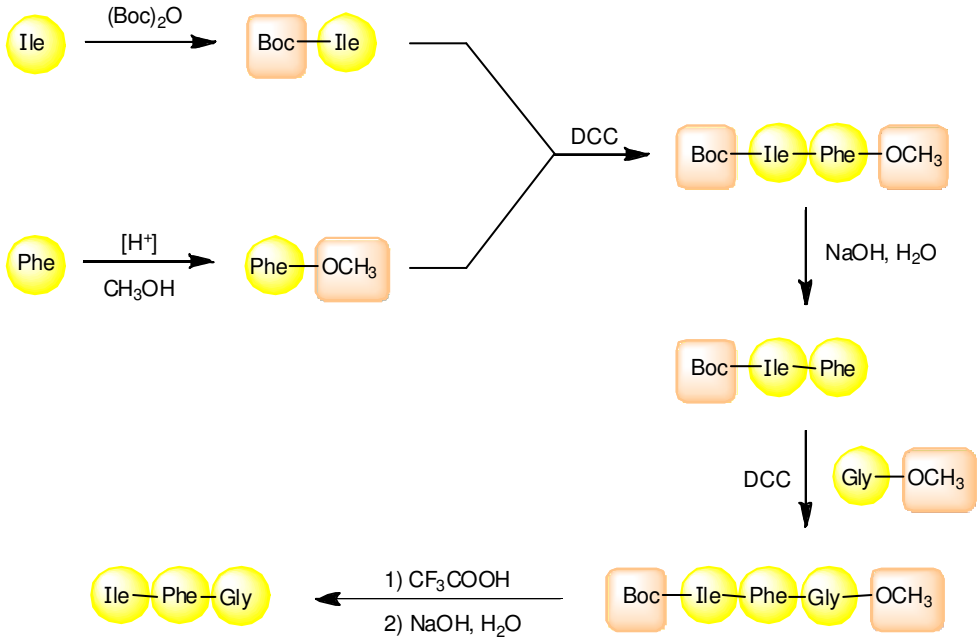
b)



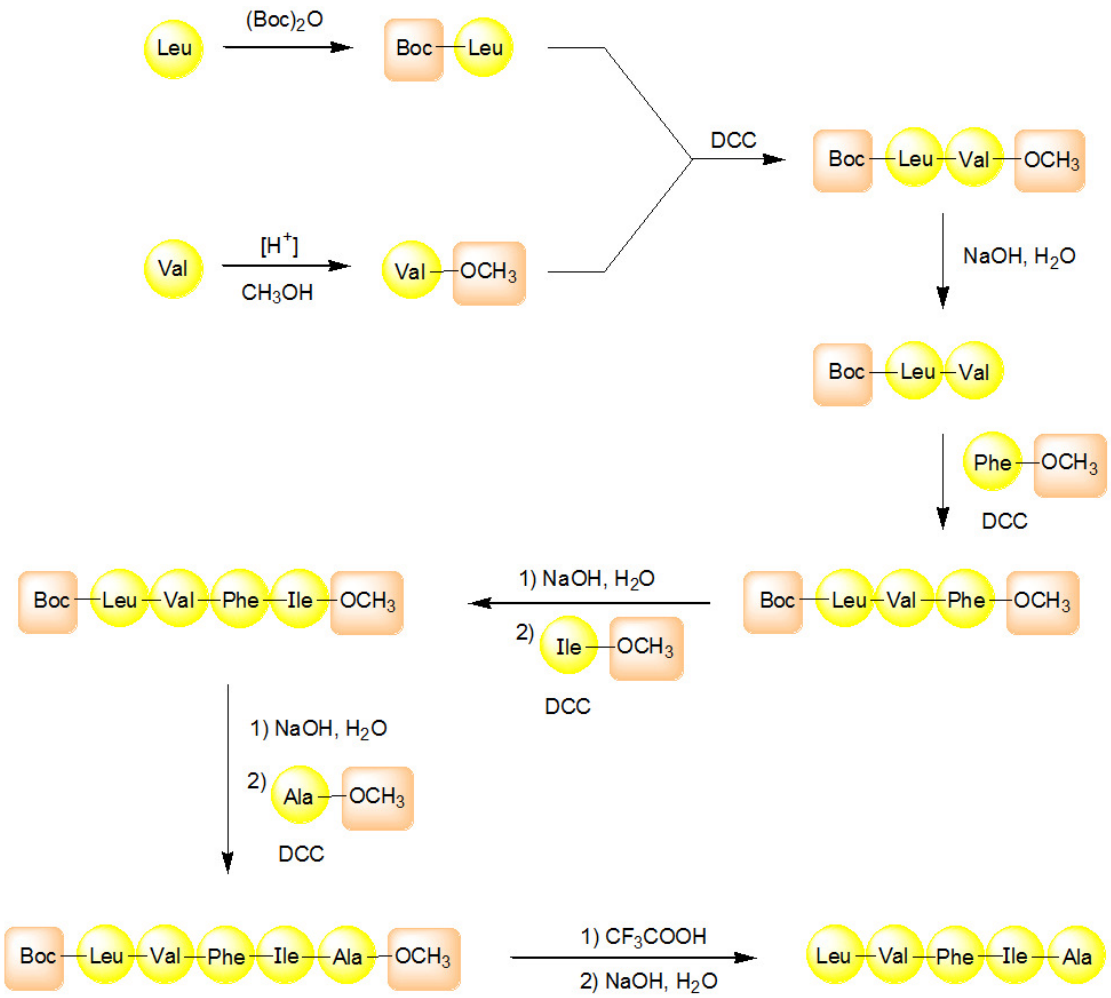
c)


Leu
(Boc)2O
Boc—Leu
DCC
Boc—Leu—Val—OCH3
1) CF3COOH
2) NaOH, H2O
Leu—Val
Val
[H+]
CH3OH
Val—OCH3

25.35.

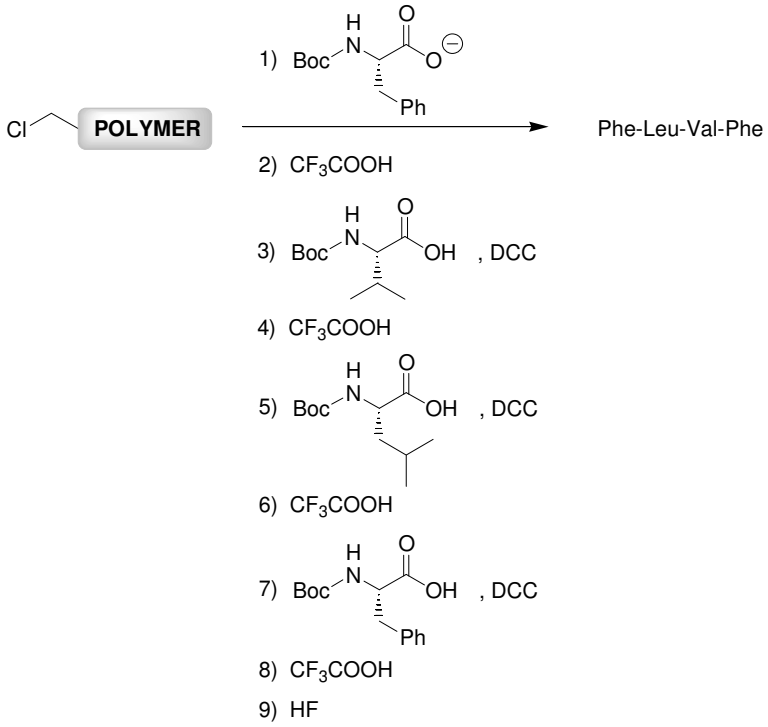

Ile
(Boc)2O
Boc—Ile
DCC
Boc—Ile—Phe—OCH3
Phe
[H+]
CH3OH
Phe—OCH3
NaOH, H2O
Boc—Ile—Phe
DCC
Gly—OCH3
Ile—Phe—Gly
1) CF3COOH
2) NaOH, H2O
Boc—Ile—Phe—Gly—OCH3

25.36.

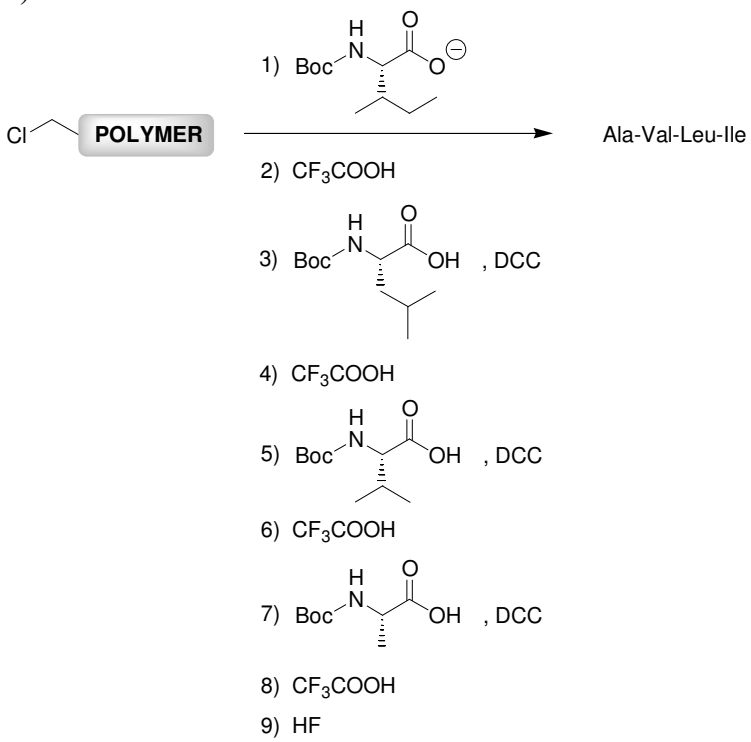

Leu
(Boc)2O
Boc—Leu
Val
[H+]
CH3OH
Val—OCH3
DCC
Boc—Leu—Val—OCH3
NaOH, H2O
Boc—Leu—Val
Phe—OCH3
DCC
Boc—Leu—Val—Phe—OCH3
1) NaOH, H2O
2) Ile—OCH3
DCC
Boc—Leu—Val—Phe—Ile—OCH3
1) NaOH, H2O
2) Ala—OCH3
DCC
Boc—Leu—Val—Phe—Ile—Ala—OCH3
1) CF3COOH
2) NaOH, H2O
Leu—Val—Phe—Ile—Ala

25.37.

a)


1) Boc
Ph
Cl
POLYMER
Phe-Leu-Val-Phe
2) CF3COOH
3) Boc
OH , DCC
4) CF3COOH
5) Boc
OH , DCC
6) CF3COOH
7) Boc
OH , DCC
Ph
8) CF3COOH
9) HF

b)

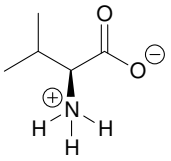
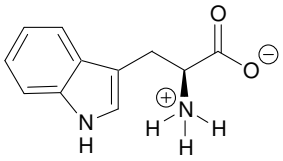
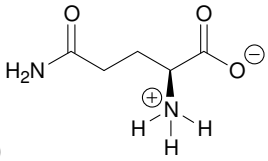
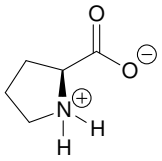

1) Boc
Cl
POLYMER
Ala-Val-Leu-Ile
2) CF3COOH
3) Boc
OH , DCC
4) CF3COOH
5) Boc
OH , DCC
6) CF3COOH
7) Boc
OH , DCC
8) CF3COOH
9) HF

25.38. (N terminus) Val-Ala-Phe (C terminus)

25.39. The regions that contain repeating glycine and/or alanine units are the most likely regions to form β sheets:

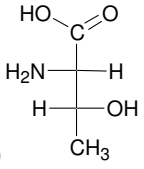
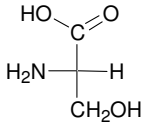
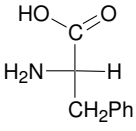
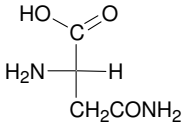
Trp-His-Pro-Ala-Gly-Gly-Ala-Val-His-Cyst-Asp-Ser-Arg-Arg-Ala-Gly-Ala-Phe

25.40.

a)  b)  c)  d) 

25.41. When applying the Cahn-Ingold-Prelog convention for assigning the configuration of a chirality center, the amino group generally receives the highest priority (1), followed by the carboxylic acid moiety (2), followed the side chain (3), and finally the H (4). Accordingly, the *S* configuration is assigned to L amino acids. Cysteine is the one exception because the side chain has a higher priority than the carboxylic acid moiety. As a result, the *R* configuration is assigned.

25.42.

a)  b)  c)  d) 

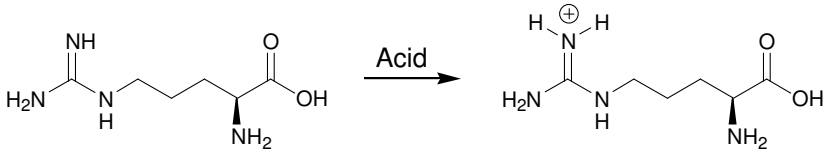
25.43.

a) Isoleucine and threonine

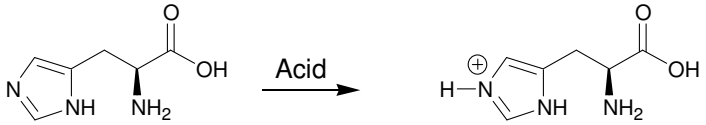
b) Isoleucine = *2S,3S*. Threonine = *2S,3R*

25.44.

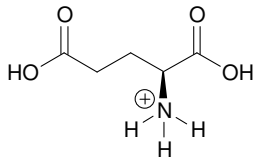
25.45. The protonated form below is highly stabilized by resonance, which spreads the positive charge over all three nitrogen atoms.

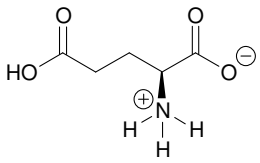


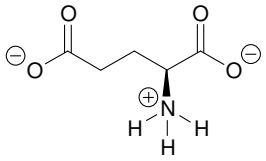
25.46. The protonated form below is aromatic. In contrast, protonation of the other nitrogen atom in the ring would result in loss of aromatic stabilization.

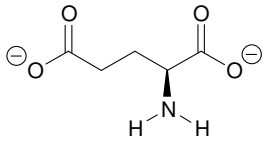


25.47.

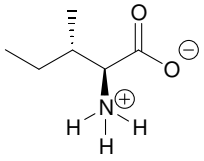
a) 

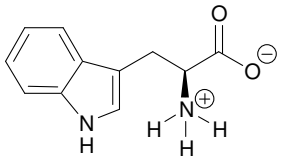
b) 

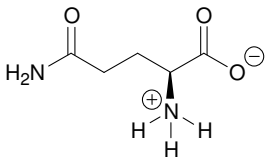
c) 

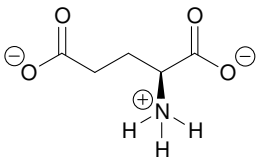
d) 

25.48.

a) 

b) 

c) 

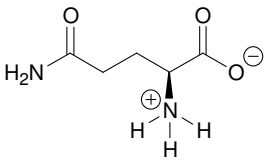
d) 

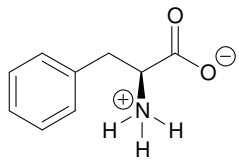
25.49.

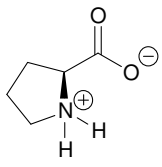
a) 6.02 b) 5.41 c) 7.58 d) 3.22

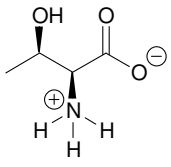
25.50. Lysozyme is likely to be comprised primarily of amino acid residues that contain basic side chains (arginine, histindine, and lysine), while pepsin is comprised primarily of amino acid residues that contain acidic side chains (aspartic acid and glutamic acid).

25.51.

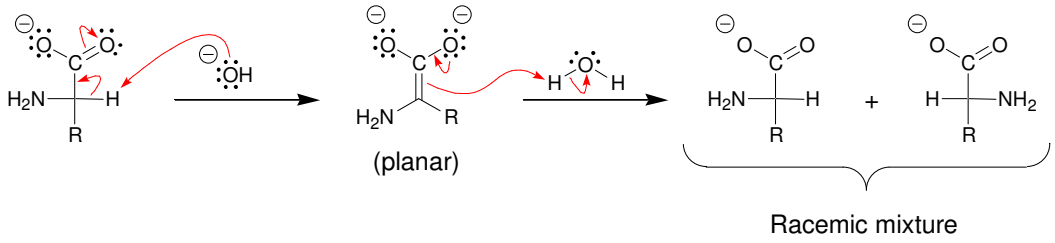
a) 

b) 

c) 

d) 

25.52.



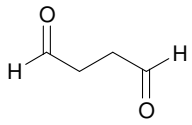
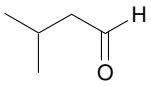
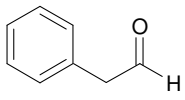
25.53.

The pI of Gly = 5.97, the pI of Gln = 5.65, and the pI of Asn = 5.41.

a) At pH = 6.0, Asn will travel the farthest distance.

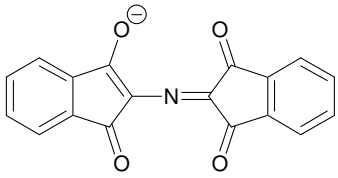
b) At pH = 5.0, Gly will travel the farthest distance.

25.54.

a)  b)  c)  d) no reaction

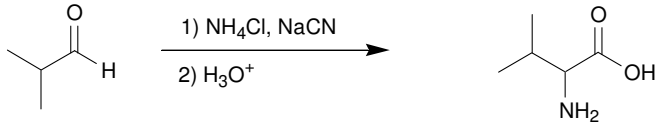
25.55.

a) Methionine, valine, and glycine.

b) 

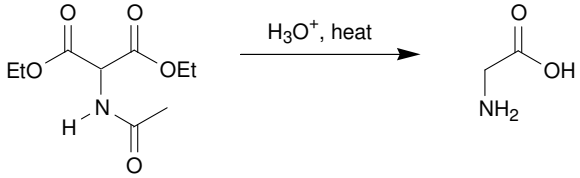
c) The compound is highly conjugated and has a λ_{max} that is greater than 400 nm (see Section 17.12)

25.56.



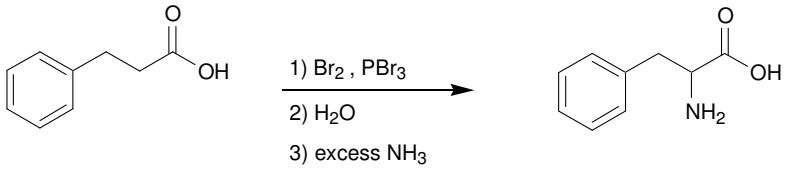
25.57. Alanine can be prepared via the amidomalonate synthesis with higher yields than valine, because the former requires an S_N2 reaction with a primary alkyl halide, while the latter requires an S_N2 reaction with a secondary (more hindered) alkyl halide.

25.58. The side chain (R) of glycine is a hydrogen atom (H). Therefore, no alkyl group needs to be installed at the α position.

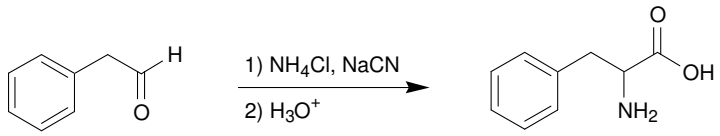


25.59.

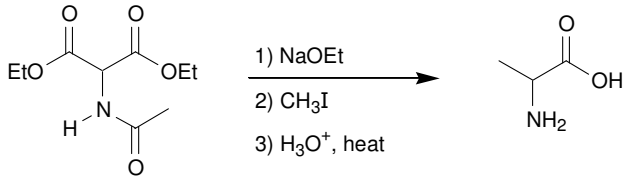
a)



b)

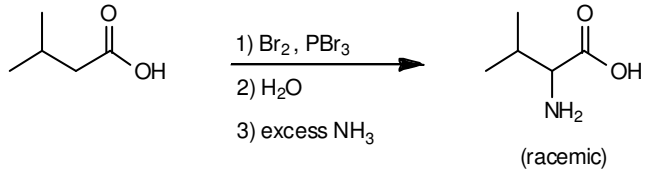


c)



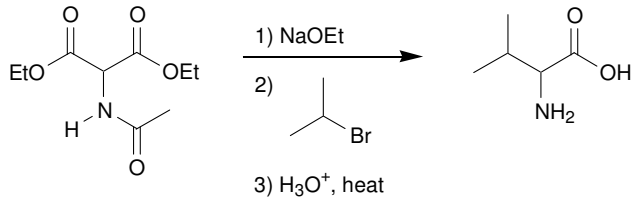
25.60.

a)

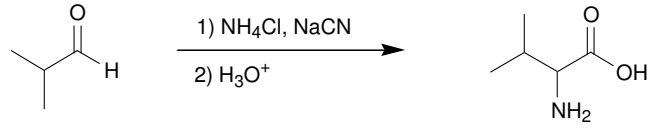


(racemic)

b)

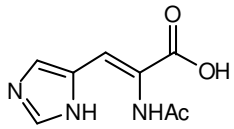


c)



25.61. $20^5 = 3{,}200{,}000$

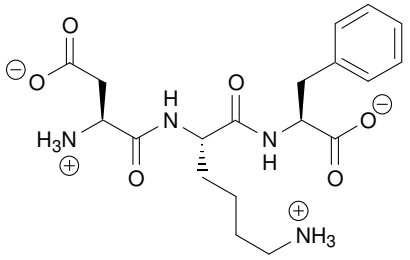
25.62.



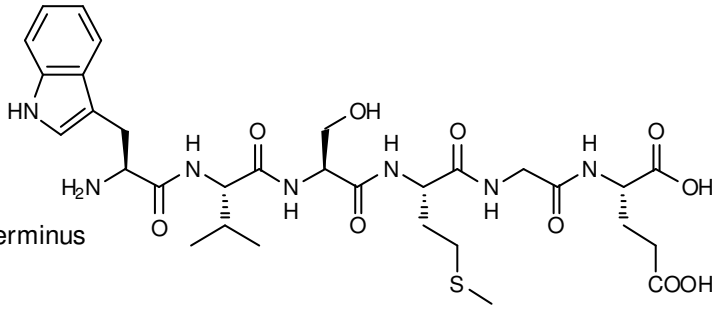
25.63.

1) Leu-Met-Val, 2) Leu-Val-Met, 3) Met-Val-Leu,
4) Met-Leu-Val, 5) Val-Met-Leu, 6) Val-Leu-Met

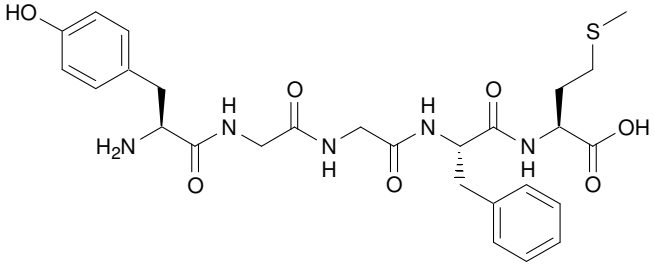
25.64.



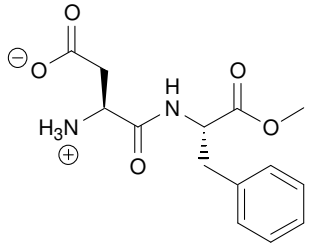
25.65.



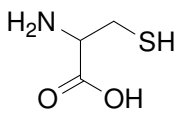
25.66.



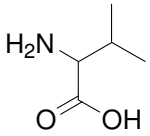
25.67.



25.68.

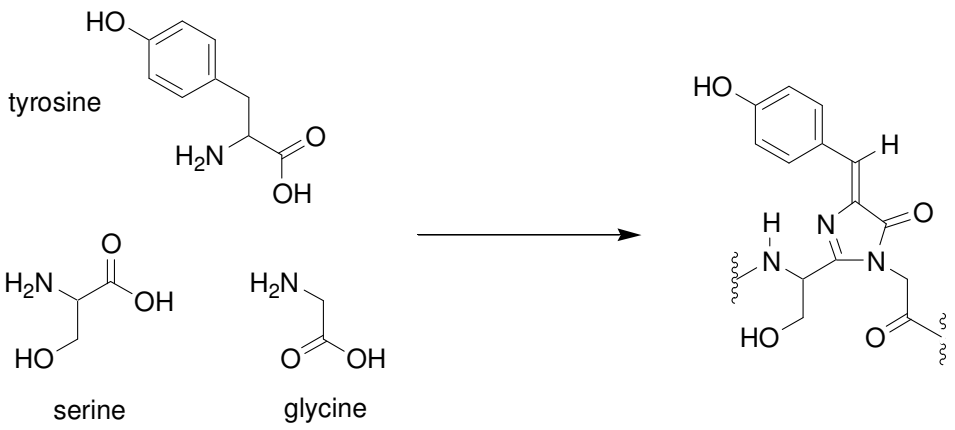


cysteine



valine

25.69.



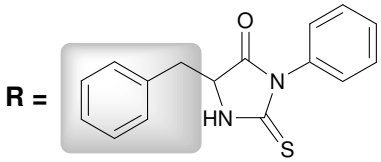
25.70. It does not react with phenyl isothiocyanate so it must not have a free N terminus. It must be a cyclic tripeptide:

25.71.

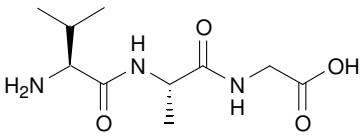
a) ***Arg*** **+** ***Pro-Pro-Gly-Phe-Ser-Pro-Phe-Arg***

b) ***Arg-Pro-Pro-Gly-Phe*** **+** ***Ser-Pro-Phe*** **+** ***Arg***

25.72. Phenylalanine



25.73. Val-Ala-Gly:

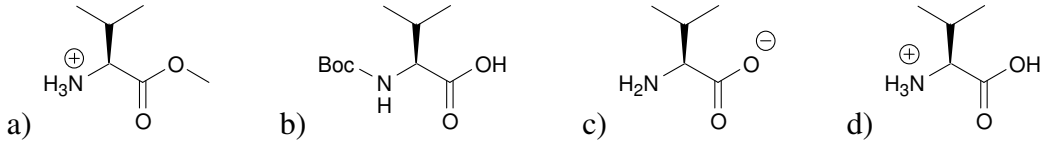


25.74. There cannot be any disulfide bridges in this peptide, because it has no cysteine residues, and only cysteine residues form disulfide bridges.

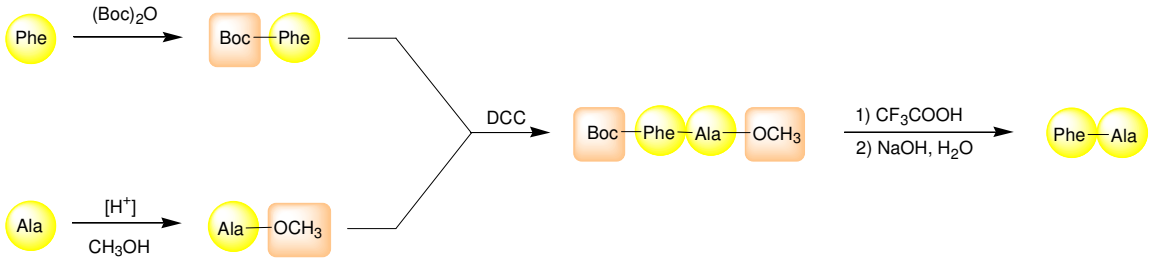
His-Ser-Gln-Gly-Thr-Phe-Thr-Ser-Asp-Tyr-Ser-Lys-Tyr-Leu-Asp-Ser-Arg-Arg-Ala-Gln-Asp-Phe-Val-Gln-Trp-Leu-Met-Asn-Thr

25.75. Prior to acylation, the nitrogen atom of the amino group is sufficiently nucleophilic to attack phenyl isothiocyanate. Acylation converts the amino group into an amide moiety, and the lone pair of the nitrogen atom is delocalized via resonance, rendering it much less nucleophilic.

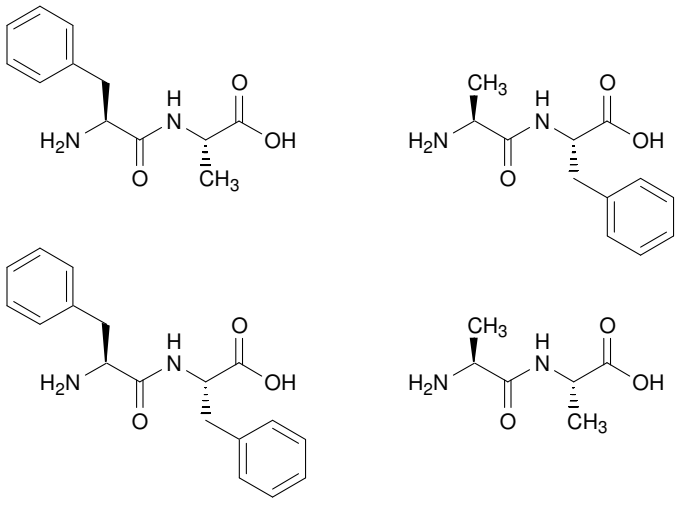
25.76.



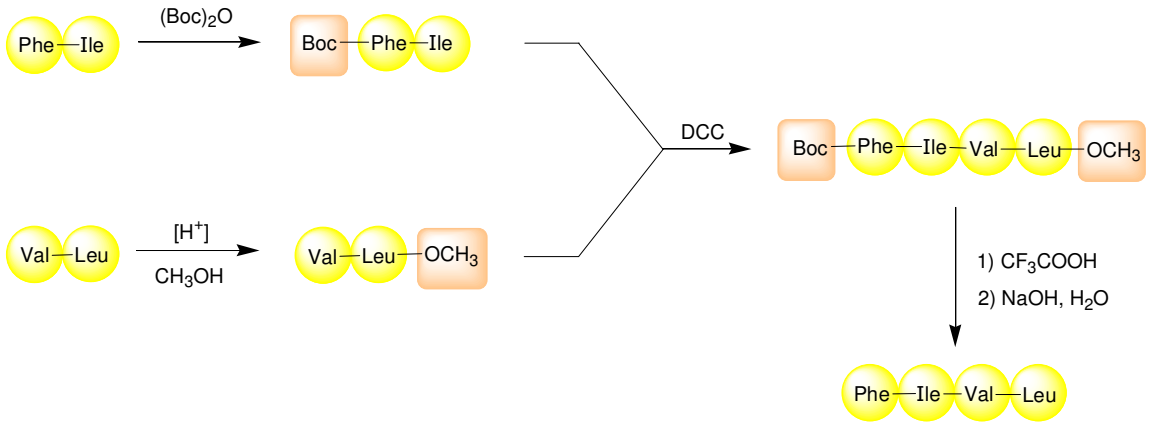
25.77.



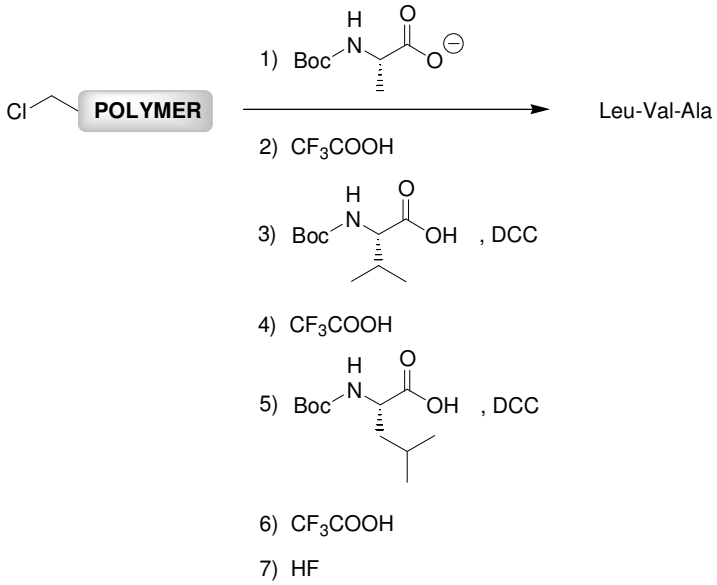
25.78.



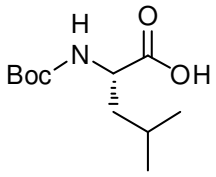
25.79.



25.80.

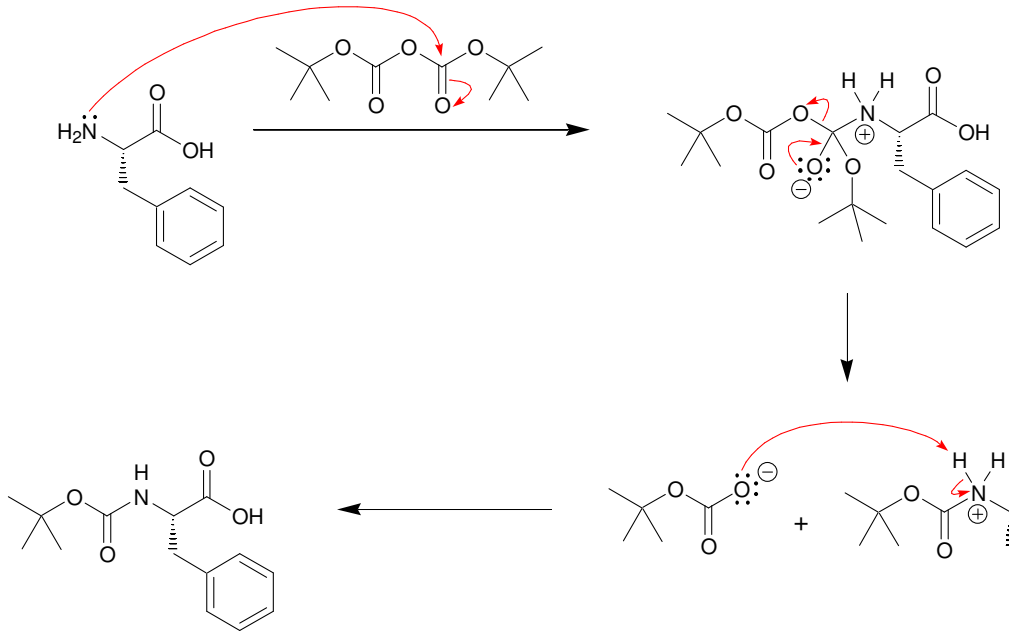


25.81.

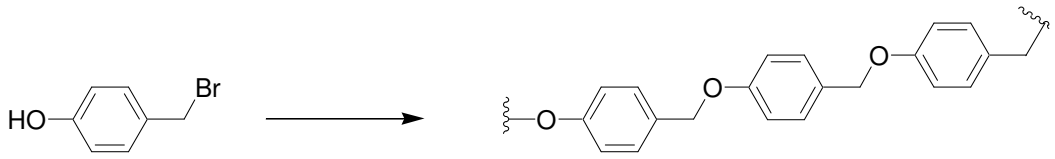


25.82. A proline residue cannot be part of an α helix, because it lacks an N-H proton and does not participate in hydrogen bonding. (The amino acid proline does indeed have an N-H group, but when incorporated into a peptide, the proline residue does not have an N-H group)

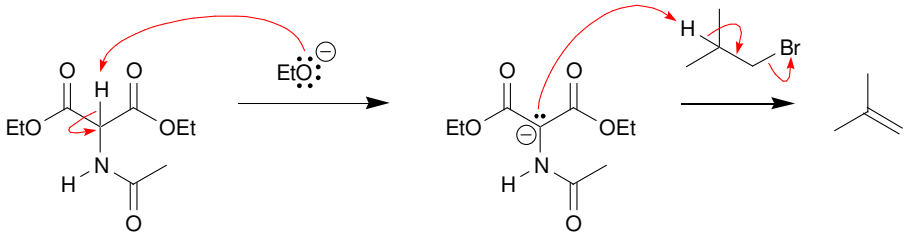
25.83.



25.84.



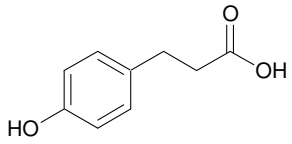
25.85. The stabilized enolate ion (formed in the first step) can function as a base, rather than a nucleophile, giving an E2 reaction:



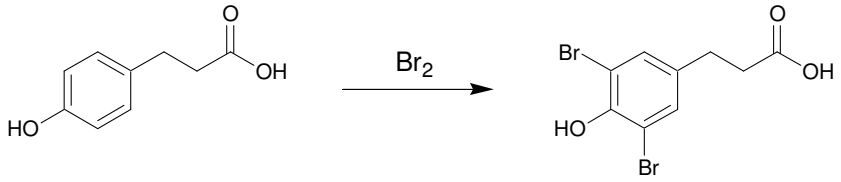
25.86. The lone pair on that nitrogen atom is highly delocalized via resonance and is participating in aromaticity. Accordingly, the lone pair is not free to function as a base.

25.87.

a)



b)



25.88. At low temperature, the barrier to rotation keeps the two methyl groups in different electronic environments (one is *cis* to the C=O bond and the other is *trans* to the C=O bond), and they therefore give rise to separate signals. At high temperature, there is sufficient energy to overcome the energy barrier, and the protons change electronic environments on a timescale that is faster than the timescale of the NMR spectrometer. The result is an averaging effect which gives rise to only one signal.

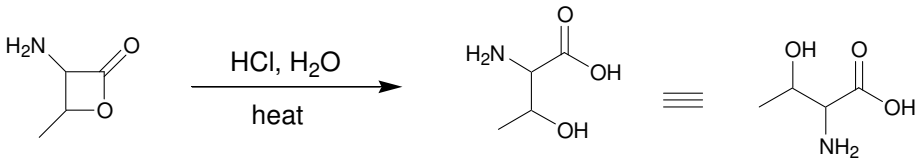
25.89.

a) The COOH group does not readily undergo nucleophilic acyl substitution because the OH group is not a good leaving group. By converting the COOH group into an activated ester, the compound can now undergo nucleophilic acyl substitution because it has a good leaving group.

b) The nitro group stabilizes the leaving group via resonance. As described in Chapter 19, the nitro group serves as a reservoir for electron density.

c) The nitro group must be in the ortho or para position in order to stabilize the negative charge via resonance. If the nitro group is in the meta position, the negative charge cannot be pushed onto the nitro group.

25.90.



threonine