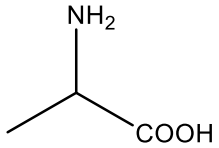
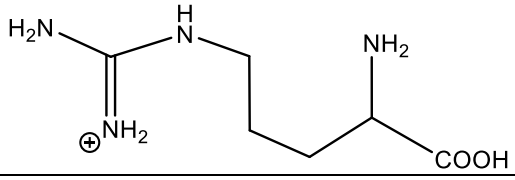
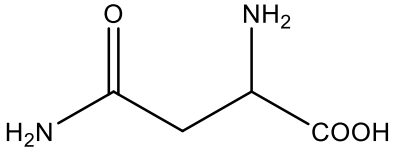
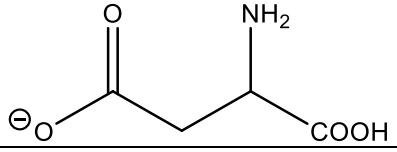
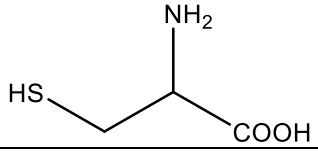
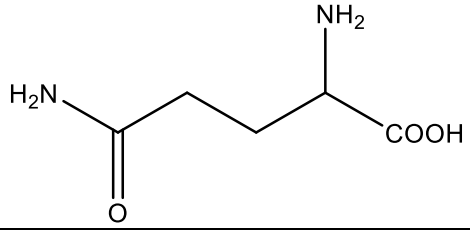
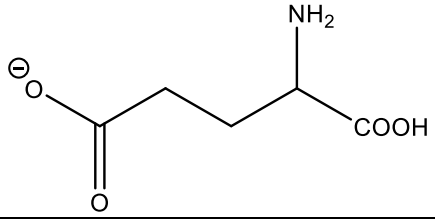
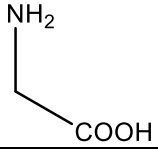
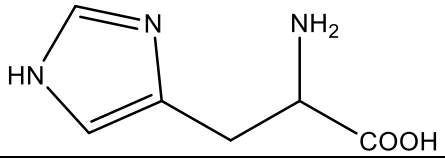
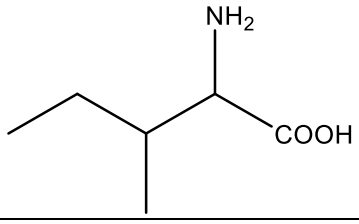
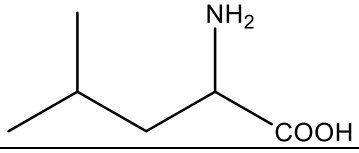
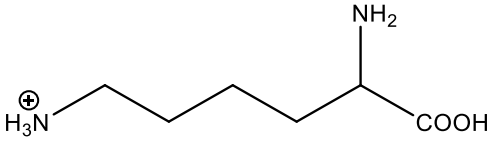
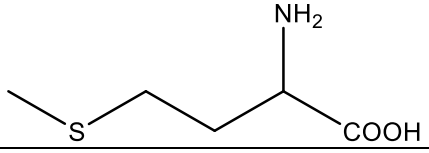
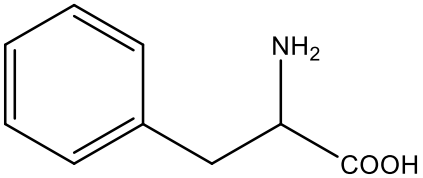
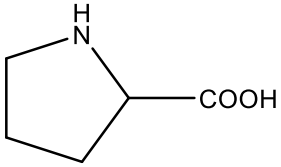
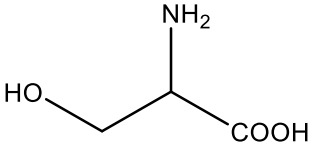
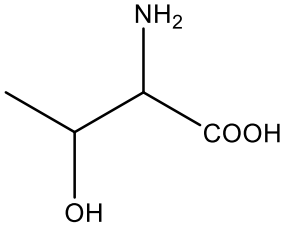
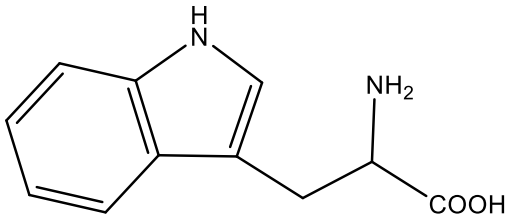
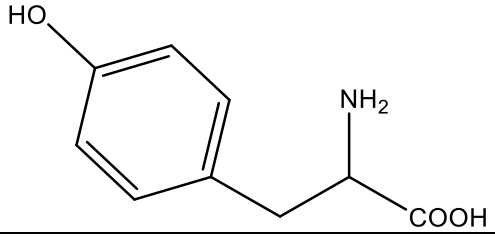
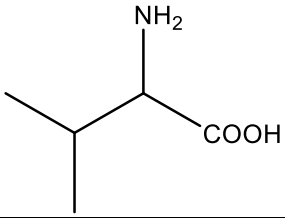
Natural Amino Acids

Amino Acid	Three Letter Code	One Letter Code	Structure	Properties
Alanine	Ala	A		Hydrophobic
Arginine	Arg	R		Positively Charged
Asparagine	Asn	N		Polar Uncharged
Aspartic Acid	Asp	D		Negatively Charged
Cysteine	Cys	C		Special Case
Glutamine	Gln	Q		Polar Uncharged
Glutamic Acid	Glu	E		Negatively Charged
Glycine	Gly	G		Special Case

Amino Acid	Three Letter Code	One Letter Code	Structure	Properties
Histidine	His	H		Positively Charged
Isoleucine	Ile	I		Hydrophobic
Leucine	Leu	L		Hydrophobic
Lysine	Lys	K		Positively Charged
Methionine	Met	M		Hydrophobic
Phenylalanine	Phe	F		Hydrophobic Absorbs @ 280 nm
Proline	Pro	P		Special Case
Serine	Ser	S		Polar Uncharged
Threonine	Thr	T		Polar Uncharged

Amino Acid	Three Letter Code	One Letter Code	Structure	Properties
Tryptophan	Trp	W		Hydrophobic Absorbs @ 280 nm
Tyrosine	Tyr	Y		Hydrophobic Absorbs @ 280 nm
Valine	Val	V		Hydrophobic

* The amino acid structures are as shown at pH 7.4.

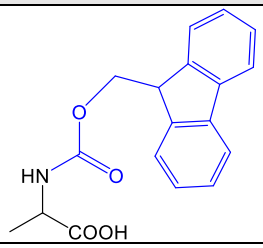
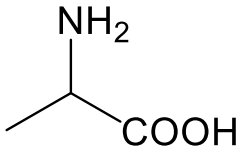
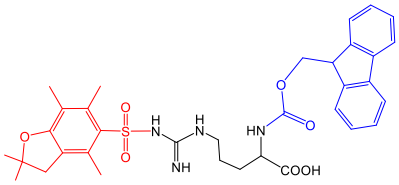
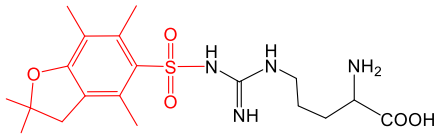
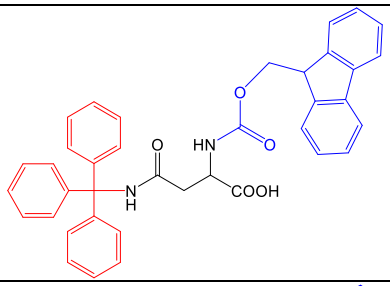
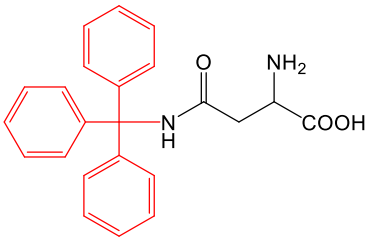
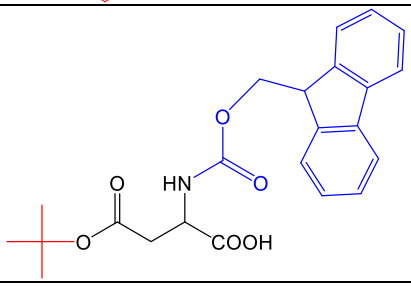
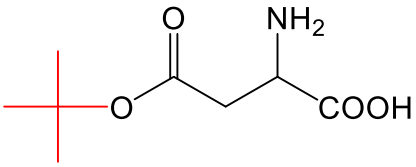
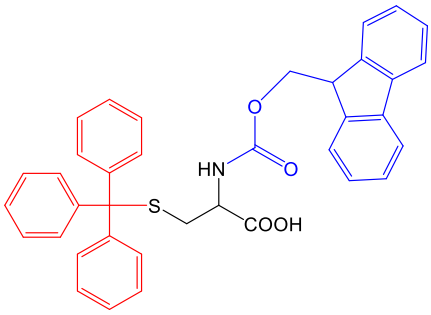
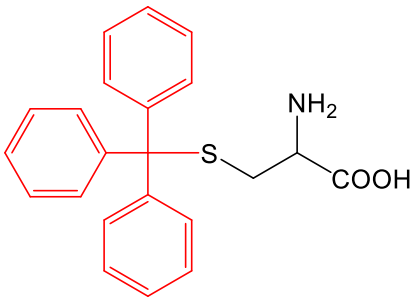
Amino Acid Side-Chain Protection

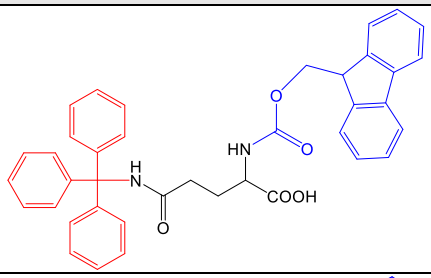
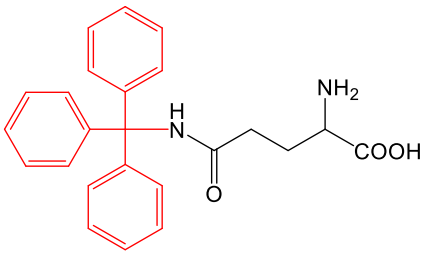
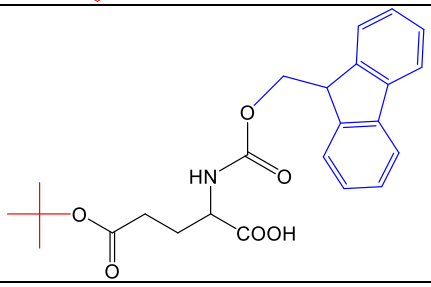
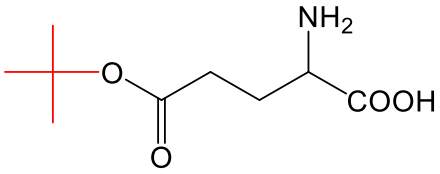
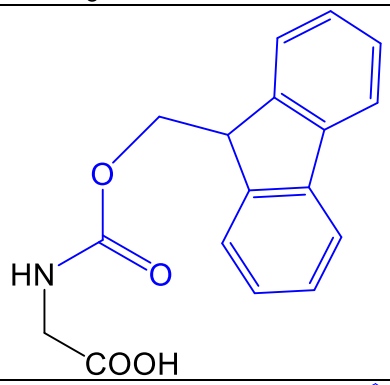
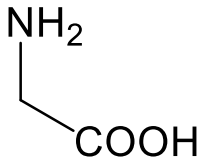
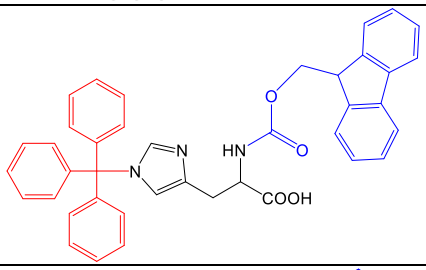
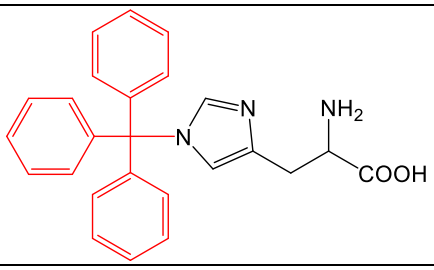
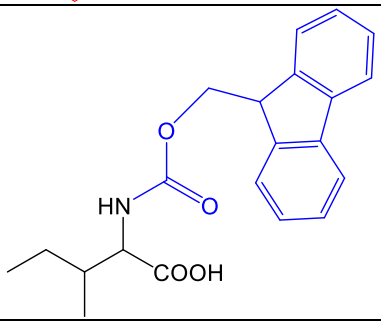
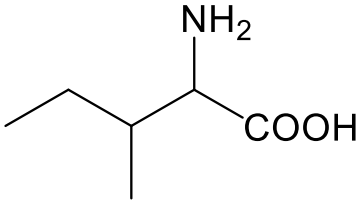
Amino Acid (Functionality Protected)	Protecting Groups	Deprotection	Comments
Arg (Guanidino N)	Mtr	TFA at 35 °C	Best in small peptides with only one Arg residue.
	Pmc	TFA	Standard
	Pbf [1]	TFA	Standard, less likely to react with Trp residues during cleavage than Pmc. Best for peptides with multiple Arg residues.[2]
Asp/Glu (Carboxyl)	**OtBu**[3]	TFA	Standard
	OBzl	H_2/Pd, HF	Seldom used
	OcHx	HF	Seldom used
Asn/Gln (Amide)	**Trt**[4]	TFA	Standard, suppresses dehydration and increases solubility of the protected amino acid. Prevents side reaction of amide and carbodiimide to form nitriles.
Cys (Sulfhydryl)	Acm	Hg(II), I_2	Iodine forms S-S bond during deprotection. Stable to cleavage conditions, useful for preparing protected peptides.
	tBu	TFSMA, Hg(II), TFA/DMSO/Anisole	Useful in selective formation of multiple disulfide bridges.[5]
	pMeOBzl	TFMSA	Useful in selective formation of multiple disulfide bridges.[5]
	Mmt	1% TFA	On resin modification
	Trt[4]	TFA, I_2	Standard

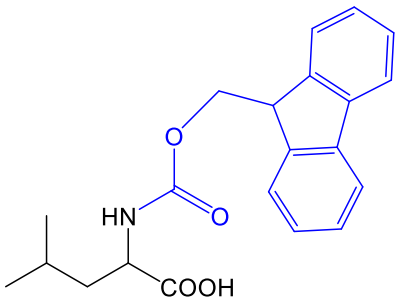
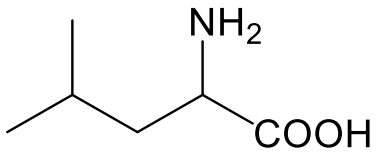
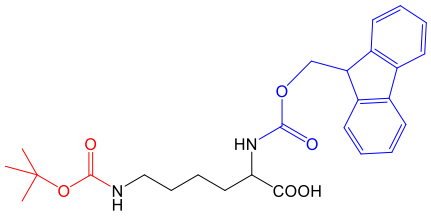
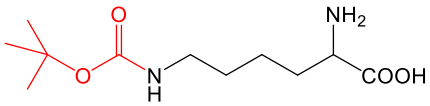
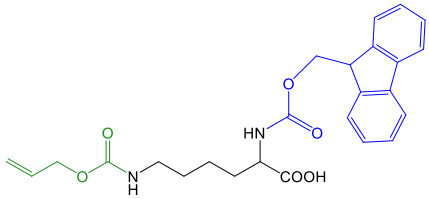
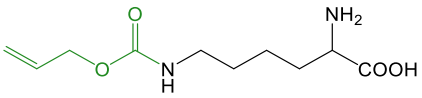
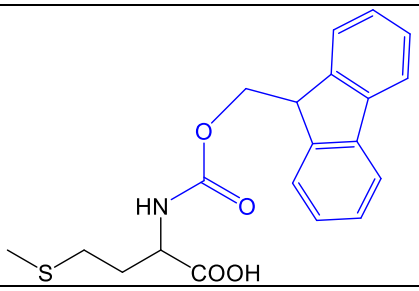
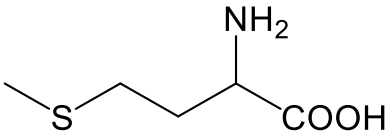
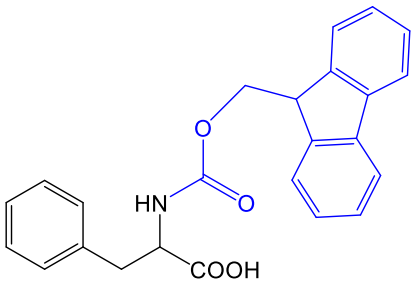
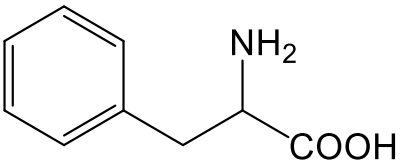
Amino Acid	Protecting Groups	Deprotection	Comments
His (Imidazole)	Fmoc	Piperidine	Temporary
	Trt[4]	90% TFA/DCM	Standard[6]
	Mtt	15% TFA/DCM	Standard
Lys/Orn (Amino)	**Boc**[7]	TFA	Standard
	tfa	TFA	Does not form side products during cleavage.
	Trt	TFA	Fewer side reactions during cleavage.
	Mtt	1% TFA/DCM	On resin modification
	Dde, ivDde	Hydrazine	N-terminal Fmoc protecting group must be replaced with Boc before hydrazine treatment.
	Fmoc	Piperidine	Temporary
Ser/Thr (Hydroxyl)	**tBu**[3]	TFA	Standard
	Trt	1% TFA/DCM	On resin modification
	Bzl	H_2/Pd, HF	Seldom used
Trp (Indole)	**Boc**[7]	TFA	Greatly reduces byproducts formed during cleavage.
Tyr (Phenol)	**tBu**[3]	TFA	Standard
	Bzl	H_2/Pd, HF	Seldom used

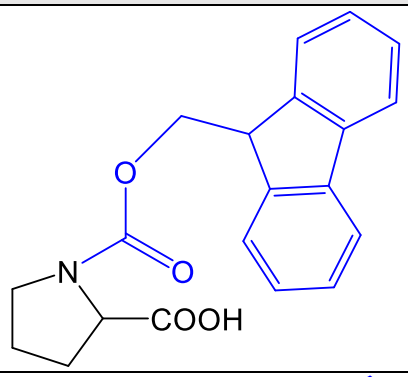
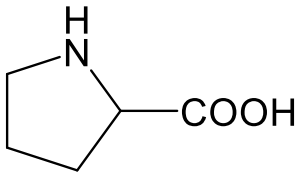
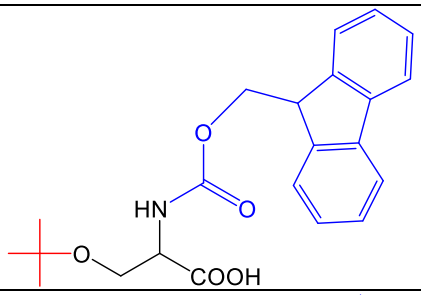
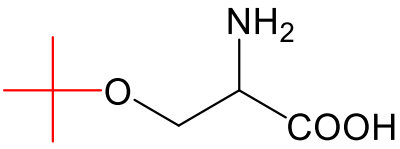
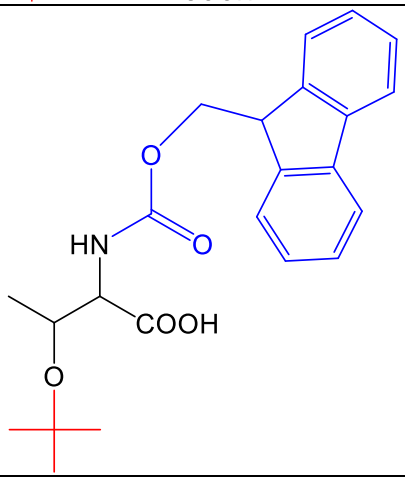
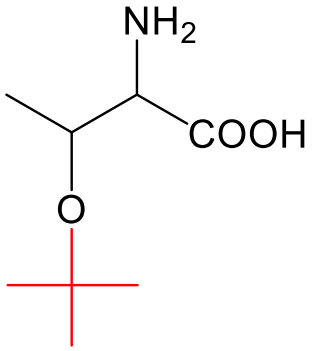
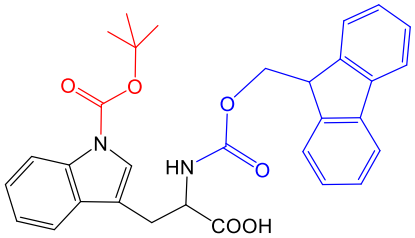
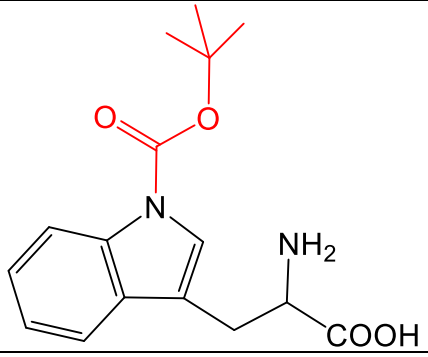
* Protecting groups in **bold** are the recommended protecting groups for protocols used within the PPMC.

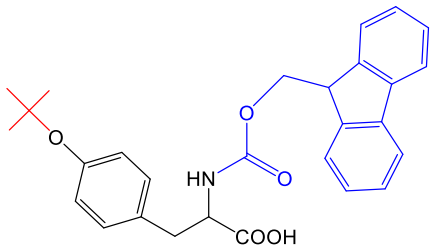
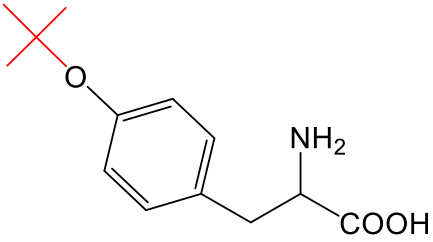
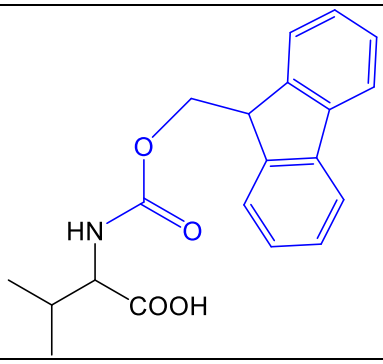
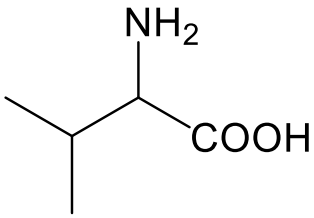
PPMC Recommended Protected Amino Acids

Amino Acid	Protected Structure	Protected Molecular Weight (g/mol)	Fmoc Deprotected Structure	Fmoc Deprotected Molecular Weight (g/mol)
Fmoc-Ala-OH		311.34		89.09
Fmoc-Arg(Pbf)-OH		648.78		426.53
Fmoc-Asn(Trt)-OH		596.68		374.44
Fmoc-Asp(OtBu)-OH		411.45		189.21
Fmoc-Cys(Trt)-OH		585.72		363.48

Amino Acid	Protected Structure	Protected Molecular Weight (g/mol)	Fmoc Deprotected Structure	Fmoc Deprotected Molecular Weight (g/mol)
Fmoc-Gln(Trt)-OH		610.71		388.47
Fmoc-Glu(OtBu)-OH		425.48		203.24
Fmoc-Gly-OH		297.31		75.07
Fmoc-His(Trt)-OH		619.72		397.48
Fmoc-Ile-OH		353.42		131.18

Amino Acid	Protected Structure	Protected Molecular Weight (g/mol)	Fmoc Deprotected Structure	Fmoc Deprotected Molecular Weight (g/mol)
Fmoc-Leu-OH		353.42		131.18
Fmoc-Lys(Boc)-OH		468.55		246.31
Fmoc-Lys(Alloc)-OH		452.51		230.26
Fmoc-Met-OH		371.45		149.21
Fmoc-Phe-OH		387.44		165.19

Amino Acid	Protected Structure	Protected Molecular Weight (g/mol)	Fmoc Deprotected Structure	Fmoc Deprotected Molecular Weight (g/mol)
Fmoc-Pro-OH		337.38		115.13
Fmoc-Ser(tBu)-OH		383.44		161.20
Fmoc-Thr(tBu)-OH		397.47		175.23
Fmoc-Trp(Boc)-OH		526.59		304.35

Amino Acid	Protected Structure	Protected Molecular Weight (g/mol)	Fmoc Deprotected Structure	Fmoc Deprotected Molecular Weight (g/mol)
Fmoc-Tyr(tBu)-OH		459.54		237.30
Fmoc-Val-OH		339.39		117.15

* Groups highlighted in **blue** are base labile groups, which is the Fmoc group.

* Groups highlighted in **red** are acid labile groups.

* The group highlighted in **green** needs special procedures to be removed. See Alloc removal protocols for this.

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