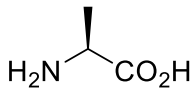
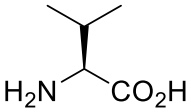
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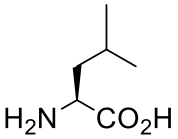
Appendix 1 Amino acid residues.



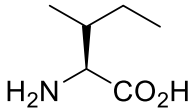
L-alanine
Ala (A)



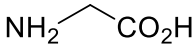
L-valine
Val (V)



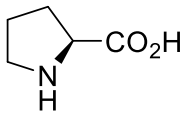
L-leucine
Leu (L)



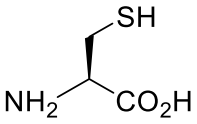
L-alloisoleucine
Ile (I)



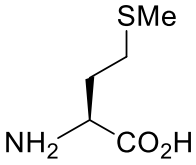
glycine
Gly (G)



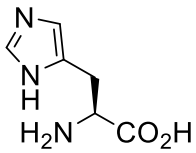
L-proline
Pro (P)



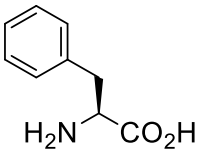
L-cysteine
Cys (C)



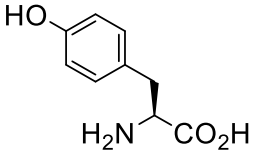
L-methionine
Met (M)



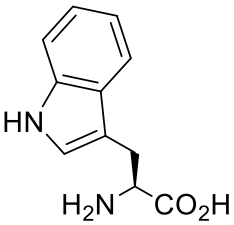
L-histidine
His (H)



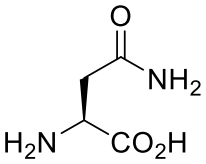
L-phenylalanine
Phe (F)



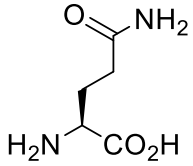
L-tyrosine
Tyr (Y)



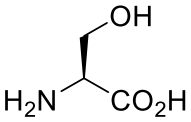
L-tryptophan
Trp (W)



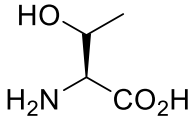
L-asparagine
Asn (N)



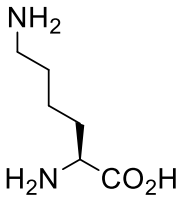
L-glutamine
Gln (Q)



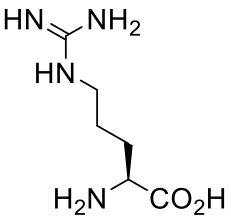
L-serine
Ser (S)



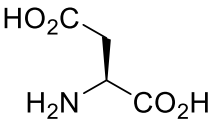
L-threonine
Thr (T)



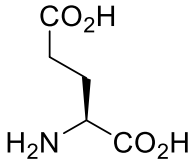
L-lysine
Lys (K)



L-arginine
Arg (R)



L-aspartic acid
Asp (D)



L-glutamic acid
Glu (E)

Appendix 2 List of $P450_{BM3}$ variants used in the thesis.

Table 1 The base variants and their containing mutations.

Base variant	Mutations
GV	A74G/F87V
GVQ	A74G/F87V/L188Q
GAQ	A74G/F87A/L188Q
GGQ	A74G/F87G/L188Q
GLQ	A74G/F87L/L188Q
LQ	F87L/L188Q
K19	H171L/Q307H/N319Y
KU3	N239H/I259V/A276T
KSK48	R179H/L233V/S270I/Q307H/N319Y
R1	R47L/Y51F/H171L
R19	R47L/Y51F/H171L/Q307H/N319Y
RP	R47L/Y51F/I401P
RT2	R47L/Y51F/A191T/N239H/I259V/A276T/L353I

Table 2 The $P450_{BM3}$ variants (both in initial screening plates and 2nd generation sub-libraries*) used in the thesis.

No.	$P450_{BM3}$ variant
1	A330P
2	A82F/I263F
3	A82M/A330P
4	A82T/I263R
5	F81W/T260A
6	F87A
7	GAQ/I263G*
8	GAQ/I263G/A328G*
9	GAQ/I263G/A328L*
10	GGQ*
11	GGQ/I263G/A328F*
12	GGQ/I263G/A328G*
13	GGQ/I263G/A328L*
14	GLQ/I263G*
15	GLQ/I263G/A328F*
16	GLQ/I263G/A328G*
17	GLQ/I263G/A328I*
18	GLQ/I263G/A328L*
19	GLQ/S72W/I263G*
20	GV/A184I
21	GV/A184I/A264G*
22	GV/A184I/A264G/A328G*
23	GV/A184I/A328G*
24	GV/A184I/I263G*

25	GV/A184I/I263G/A264G/A328G*
26	GV/A184I/I263G/A328G*
27	GV/A184I/T260G*
28	GV/A184I/T260G/A328G*
29	GVQ
30	GVQ/A264G
31	GVQ/A328G*
32	GVQ/A330W
33	GVQ/A82M/I263G
34	GVQ/I263A/A328I
35	GVQ/I263G
36	GVQ/I263G/A264G/A328G*
37	GVQ/I263G/A328F*
38	GVQ/I263G/A328I*
39	GVQ/I263G/A328L
40	GVQ/N70S*
41	GVQ/T260G*
42	GVQ/V78L/I263G
43	H171L/I263G*
44	I263A/A330P
45	I263G
46	K19*
47	K19/A82M/A264G/A328G*
48	K19/A82M/F87A
49	K19/A82M/F87A/A264G*
50	K19/A82M/F87A/A264G/A328G*
51	K19/A82M/F87A/A330W
52	K19/A82M/F87A/E267F
53	K19/A82M/F87A/I263G
54	K19/A82M/F87A/I263G/A264G*
55	K19/A82M/F87A/I263G/A264G/A328G*
56	K19/A82M/F87A/I263G/A328G*
57	K19/A82M/F87A/T260G/A328G*
58	K19/F81W/F87A
59	K19/F87A/A184I/A328I
60	K19/F87A/I263A
61	K19/F87A/I263A/A328I
62	K19/F87A/I263G*
63	K19/F87V
64	K19/F87V/A184I*
65	K19/F87V/A264G
66	K19/F87V/A328I
67	K19/F87V/A328V
68	K19/F87V/E267V
69	K19/F87V/I263A/A328I
70	K19/F87V/I263G

71	K19/F87V/Q403P
72	K19/V78I/F87A/A328I
73	K19/V78I/F87V/E267V
74	K19/Y51L/F87A/A328I
75	KSK48
76	KU3/A328I/A330P
77	KU3/A330P
78	KU3/S72W/A330P
79	KU3/V78I/A330P
80	LQ/S72A/I263G/A328G*
81	R1/A82M/I263G*
82	R1/F81W/I263G*
83	R1/I263G*
84	R1/I263G/K202KPG*
85	R1/I263G/L437LA*
86	R1/I263G/L437LF*
87	R1/I263G/L437LH*
88	R1/I263G/L437LM*
89	R1/I263G/L437LS*
90	R1/I263G/L437LV*
91	R1/I263G/L437S*
92	R1/I263G/L437VL*
93	R1/I263G/R398H*
94	R1/V78I/I263G/L437LA*
95	R1/V78I/I263G/L437LH*
96	R1/V78I/I263G/L437LI*
97	R1/V78I/I263G/L437LM*
98	R1/V78I/I263G/L437LS*
99	R1/V78I/I263G/L437LV*
100	R1/V78I/I263G/L437VL*
101	R19*
102	R19/A184I/A328L*
103	R19/A184I/T260G*
104	R19/A328G/P329G/A330G*
105	R19/A328L*
106	R19/A330S*
107	R19/A330W
108	R19/A82M/A184I/T260G*
109	R19/A82M/G265GG*
110	R19/A82M/I263G*
111	R19/A82M/I263G/A264G/A328G*
112	R19/A82M/I263G/A328G*
113	R19/A82M/I263W/A328G*
114	R19/A82M/P329G/A330W*
115	R19/A82M/T260G*
116	R19/A82M/T260G/A328G/P329G/A330G*

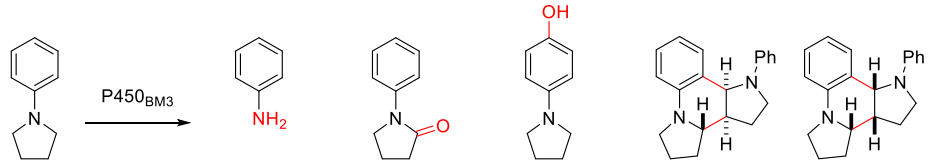
117	R19/F81W/F87A/T260G/A328G*
118	R19/F87A
119	R19/F87A/ A328G/P329G/A330G*
120	R19/F87A/W90V*
121	R19/F87A/A184I
122	R19/F87A/A184I/A264G*
123	R19/F87A/A184I/A264G/A328G*
124	R19/F87A/A184I/I259G/I263G*
125	R19/F87A/A184I/I263G/A264G*
126	R19/F87A/A184I/I263G/A264G/A328G*
127	R19/F87A/A184I/I263G/A328G*
128	R19/F87A/A184I/L262G*
129	R19/F87A/A184I/S270G*
130	R19/F87A/A184I/T260G*
131	R19/F87A/A184I/T260G/A328G*
132	R19/F87A/A184I/T269G*
133	R19/F87A/A264G/A328G
134	R19/F87A/A328F
135	R19/F87A/A328G
136	R19/F87A/A328G/P329G/A330G
137	R19/F87A/A328I
138	R19/F87A/A328L
139	R19/F87A/E267F/A328I
140	R19/F87A/G265GG
141	R19/F87A/I259G/I263G*
142	R19/F87A/I259G/I263G/A328G*
143	R19/F87A/I263G
144	R19/F87A/I263G/A264G*
145	R19/F87A/I263G/A328G*
146	R19/F87A/I263G/A328L*
147	R19/F87A/L262G*
148	R19/F87A/L262G/A328G*
149	R19/F87A/S270G*
150	R19/F87A/S270G/A328G*
151	R19/F87A/T260G*
152	R19/F87A/T260G/A328G*
153	R19/F87A/T260G/A328G/P329G/A330G*
154	R19/F87A/T260G/P329G/A330W*
155	R19/F87A/T269G*
156	R19/F87A/T269G/A328G*
157	R19/F87A/V78I/A184I/A328I*
158	R19/F87I
159	R19/F87I/L437LV*
160	R19/I263A/A328L*
161	R19/I263G*
162	R19/I263G/A264G/A328G*

163	R19/I263G/A328G*
164	R19/I263G/A328L*
165	R19/I263V/A330W*
166	R19/I263W/A328G*
167	R19/P329G/A330W*
168	R19/S72A/A330W*
169	R19/S72G/A330W*
170	R19/S72H/A330W*
171	R19/S72L/A330W*
172	R19/S72P/A330W*
173	R19/S72V/A330W*
174	R19/S72W/A330W*
175	R19/S72W/F87A/A328I
176	R19/T260G*
177	R19/T260G/A328G*
178	R19/T260G/Y278HA328G/P329G/A330G*
179	R19/V78I/F87A/A328I
180	R47L/Y51F
181	R47L/Y51F/I263R*
182	RP
183	RP/A330P
184	RP/A82M/I263A
185	RP/A82M/I263A/A330W*
186	RP/A82M/I263G*
187	RP/A82W/I263A
188	RP/A82W/I263G*
189	RP/E267G
190	RP/E267I
191	RP/E267M
192	RP/E267V
193	RP/F81W
194	RP/F87V
195	RP/F87V/E267V
196	RP/F87V/E267V/L437LV*
197	RP/F87V/E267V/L437VL*
198	RP/F87V/H171L/I263G*
199	RP/F87V/L188Q/E267V
200	RP/H171L
201	RP/H171L/A184I/I263G*
202	RP/H171L/I263A/E267V*
203	RP/H171L/I263G
204	RP/H171L/I263G/A328L*
205	RP/H171L/I263G/E267V*
206	RP/H171L/I263G/L437LV*
207	RP/H171L/I263G/P329G*
208	RP/I263A/A330W*

209	RP/I263A/E267V
210	RP/I263G*
211	RP/I263G/E267V*
212	RP/S72G/H171L/I263G*
213	RP/S72W/H171L/I263G*
214	RP/V78F/F87V/E267V
215	RP/V78F/F87V/E267V/L437LV*
216	RP/V78F/H171L/I263G*
217	RP/V78I/E267V
218	RP/V78I/F87V/H171L/I263G*
219	RP/V78I/H171L/I263G*
220	RT2
221	RT2/A184I/A330P
222	RT2/A330P
223	RT2/A330P/I401M
224	RT2/A330W
225	RT2/A82M/A330P
226	RT2/F81W
227	RT2/F81W/A328I
228	RT2/H171L/I263G/A330W
229	RT2/I263A/A330W
230	RT2/I401P
231	RT2/P329V/A330P
232	RT2/S72A/A328I/A330P
233	RT2/S72G/A330W*
234	RT2/S72H/A330W*
235	RT2/S72L/A330W*
236	RT2/S72R/A330W*
237	RT2/S72V/A330W*
238	RT2/S72W/A330W*
239	RT2/S72Y/A330W*
240	RT2/V78F
241	RT2/V78I/A184I/A330P
242	RT2/V78I/A330P
243	S72H/F87L/L188Q/I263G/A328G*
244	S72P/F87V/L188Q/A330W*
245	S72V/F87V/L188Q/A330W*
246	S72W/F87V/L188Q/A330W*
247	WT

Appendix 3 Substrate conversion and product distributions of screening scale reactions.

Appendix 3.1: *N*-phenyl pyrrolidine (**1**) by the TFA and TFB plates.

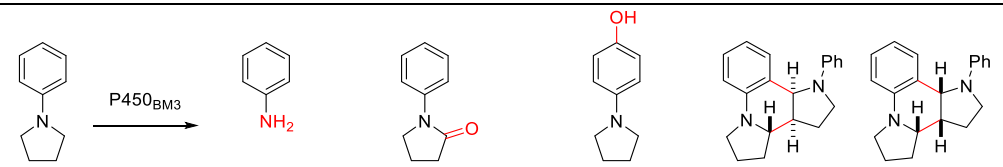


1 **2** **3** **4** **5** **6**

Mutants (*2,000 : 1*)	**Conv.**	**2**	**3**	**4**	**5**	**6**	dimers	**5 : 6**	***5,000 : 1***	**Conv.**	**2**	**3**	**4**	**5**	**6**	dimers	**5 : 6**
R19/F87A/A328I	93%	9%	4%	4%	32%	51%	83%	6/10		55%	5%	10%	–	23%	60%	83%	4/10
K19/A82M/F87A	99%	9%	1%	3%	32%	55%	87%	6/10		63%	7%	1%	–	29%	59%	88%	5/10
K19/Y51L/F87A/A328I	89%	6%	3%	5%	31%	54%	86%	6/10		56%	4%	9%	–	23%	60%	83%	4/10
K19/F87A/A184I/A328I	94%	6%	3%	4%	31%	56%	87%	6/10		61%	6%	5%	–	27%	61%	88%	4/10
RP/F87V/E267V/L437VL	99%	3%	2%	–	35%	61%	96%	6/10		81%	2%	2%	–	33%	61%	94%	5/10
K19/F87A/I263A	64%	21%	7%	11%	18%	43%	61%	4/10		32%	21%	30%	–	7%	27%	34%	2/10
RP	97%	5%	2%	–	34%	59%	93%	6/10		66%	2%	3%	–	32%	62%	94%	5/10
RP/E267V	99%	3%	–	–	36%	61%	97%	6/10		87%	2%	–	–	35%	61%	96%	6/10
RT2/F81W	99%	6%	–	–	34%	60%	94%	6/10		96%	2%	–	–	35%	62%	97%	6/10
RP/F87V/E267V	100%	6%	1%	–	32%	61%	93%	5/10		87%	4%	1%	–	31%	58%	89%	5/10
K19/F87V/A328I	67%	3%	7%	53%	11%	26%	37%	4/10		36%	4%	27%	–	10%	42%	52%	2/10
RP/F87V/E267V/L437LV	78%	7%	11%	–	29%	53%	82%	6/10		49%	10%	19%	–	18%	52%	70%	3/10
K19/V78I/F87A/A328I	85%	6%	3%	–	32%	58%	91%	6/10		47%	7%	10%	–	22%	61%	83%	4/10
RT2/A330P/I401M	97%	2%	1%	–	36%	61%	97%	6/10		48%	2%	2%	–	26%	68%	94%	4/10
RT2/A82M/A330P	88%	1%	1%	34%	22%	42%	64%	5/10		44%	2%	2%	–	21%	69%	90%	3/10
RT2/I401P	99%	6%	–	–	34%	59%	93%	6/10		97%	3%	–	–	35%	61%	96%	6/10
RT2/A330P	63%	3%	13%	1%	25%	59%	83%	4/10		38%	3%	29%	–	13%	48%	61%	3/10
RT2/A184I/A330P	74%	3%	4%	9%	30%	54%	83%	6/10		43%	3%	21%	–	17%	58%	75%	3/10
RT2/V78I/A330P	61%	3%	10%	–	28%	59%	87%	5/10		36%	3%	31%	–	13%	49%	62%	3/10

RT2	100%	4%	–	–	35%	60%	96%	6/10		91%	2%	–	–	36%	61%	97%	6/10
RP/I263A/E267V	95%	3%	1%	–	34%	62%	96%	5/10		51%	2%	1%	–	29%	62%	91%	5/10
WT	40%	3%	2%	9%	22%	63%	85%	4/10		20%	4%	11%	–	11%	39%	50%	3/10
RP/A330P	78%	2%	3%	1%	35%	60%	94%	6/10		54%	2%	2%	–	27%	68%	95%	4/10
RP/F87V	90%	19%	3%	14%	23%	41%	64%	6/10		54%	25%	11%	–	16%	47%	63%	3/10
A330P	64%	4%	13%	–	27%	57%	84%	5/10		28%	6%	43%	–	7%	34%	41%	2/10
RP/F81W	98%	6%	1%	–	35%	59%	93%	6/10		81%	2%	–	–	35%	62%	97%	6/10
RT2/S72A/A328I/A330P	100%	3%	1%	–	35%	61%	96%	6/10		54%	3%	1%	–	22%	69%	91%	3/10
RP/H171L/I263G	100%	6%	1%	16%	28%	49%	77%	6/10		93%	2%	1%	–	34%	62%	96%	6/10
RT2/P329V/A330P	100%	3%	–	–	36%	60%	97%	6/10		71%	3%	3%	–	31%	62%	93%	5/10
GVQ	96%	18%	1%	11%	25%	45%	70%	6/10		53%	43%	9%	–	9%	38%	47%	2/10
RT2/A330W	100%	4%	–	–	35%	61%	96%	6/10		–	–	–	–	–	–	–	–
F87A	84%	26%	4%	8%	21%	42%	63%	5/10		43%	57%	11%	–	5%	24%	29%	2/10
R19/F87A	100%	32%	2%	9%	17%	20%	38%	8/10		55%	80%	11%	–	2%	6%	8%	3/10
RP/A82M/I263A	98%	4%	–	2%	34%	60%	94%	6/10		65%	2%	1%	–	30%	65%	95%	5/10
RT2/V78F	100%	3%	1%	–	32%	53%	86%	6/10		88%	2%	–	–	34%	63%	97%	5/10
R47L/Y51F	98%	2%	1%	–	36%	61%	97%	6/10		55%	2%	2%	–	26%	64%	90%	4/10
K19/A82M/F87A/E267F	87%	6%	2%	6%	29%	57%	87%	5/10		20%	53%	36%	–	-	-	-	-
RP/H171L	98%	5%	–	–	35%	59%	94%	6/10		94%	2%	–	–	35%	62%	97%	6/10
RP/E267G	50%	9%	4%	2%	24%	62%	85%	4/10		24%	9%	8%	–	11%	40%	51%	3/10
KSK48	94%	2%	–	2%	32%	63%	95%	5/10		33%	5%	5%	–	17%	45%	62%	4/10
K19/F87V/Q403P	99%	14%	1%	10%	28%	47%	75%	6/10		62%	11%	4%	–	24%	61%	85%	4/10
RT2/V78I/A184I/A330P	99%	4%	1%	5%	33%	57%	91%	6/10		58%	2%	1%	–	27%	68%	95%	4/10
RP/F87V/L188Q/E267V	97%	8%	6%	–	32%	54%	86%	6/10		58%	5%	10%	–	25%	61%	86%	4/10
RP/V78F/F87V/E267V	99%	7%	1%	–	33%	59%	92%	6/10		94%	4%	1%	–	33%	62%	95%	5/10
RT2/F81W/A328I	100%	1%	–	14%	31%	54%	85%	6/10		76%	1%	–	–	31%	65%	96%	5/10
RP/E267M	99%	2%	–	–	37%	61%	97%	6/10		97%	1%	–	–	35%	63%	98%	6/10
K19/F87V/I263A/A328I	87%	7%	4%	11%	28%	50%	78%	6/10		45%	10%	15%	–	17%	56%	73%	3/10
RT2/S72W/A330W	99%	4%	2%	–	35%	59%	95%	6/10		63%	3%	3%	–	31%	63%	94%	5/10

Appendix 3.2: *N*-phenyl pyrrolidine (**1**) by the WY7 and WY8 plates.

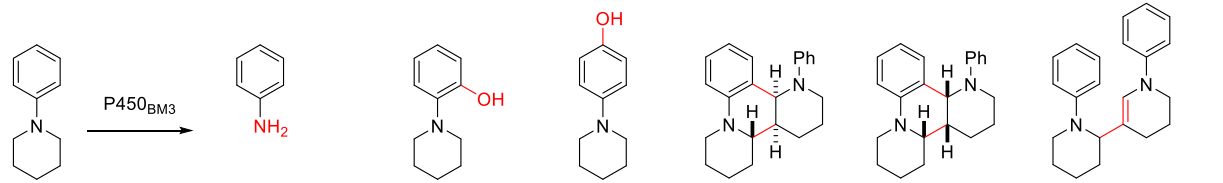


1 | **2** R19/F87A 67% TON 1,180 | **3** R19/F87A/I263G/A264G 60% TON 900 | **4** GVQ/I263G/A328L 96% TON 1,310 | **5** RP/V78I/F87V 33% TON 620 | **6** RP/V78I/F87V 51% TON 970

Mutants *8 h*	**Conv.**	**2**	**3**	**4**	**5**	**6**	dimers	**5 : 6**	*24 h*	**Conv.**	**2**	**3**	**4**	**5**	**6**	dimers	**5 : 6**
R19/A330W	19%	59%	41%	–	–	–	–	–		85%	13%	8%	–	32%	48%	80%	7/10
K19/F87A/I263G	21%	61%	39%	–	–	–	–	–		82%	30%	10%	18%	18%	24%	42%	7/10
GVQ	36%	90%	10%	–	–	–	–	–		85%	58%	9%	–	14%	18%	33%	8/10
R19/F87I	23%	42%	58%	–	–	–	–	–		82%	26%	24%	–	20%	29%	49%	7/10
K19/F87V	50%	23%	6%	37%	14%	19%	34%	7/10		90%	55%	8%	–	16%	21%	37%	8/10
K19/F87V/E267V	6%	100%	–	–	–	–	–	–		79%	50%	8%	–	16%	26%	42%	6/10
K19/A82M/F87A/I263G	16%	100%	–	–	–	–	–	–		68%	38%	15%	–	16%	31%	47%	5/10
K19/F87V/A328V	45%	19%	5%	76%	–	–	–	–		88%	17%	3%	59%	8%	13%	21%	6/10
K19/F81W/F87A	31%	85%	15%	–	–	–	–	–		81%	58%	12%	–	13%	17%	30%	8/10
K19/F87A/I263A	17%	80%	20%	–	–	–	–	–		79%	33%	8%	–	24%	35%	59%	7/10
K19/F87V/Q403P	41%	57%	16%	5%	9%	14%	23%	7/10		88%	43%	13%	–	19%	25%	44%	8/10
KU3/A328I/A330P	10%	–	100%	–	–	–	–	–		86%	9%	12%	19%	25%	36%	61%	7/10
R19/A184I/A328L	84%	–	–	100%	–	–	–	–		92%	0%	0%	90%	5%	5%	10%	9/10
R19/F87A/A328G	35%	85%	15%	–	–	–	–	–		85%	51%	12%	–	17%	20%	36%	9/10
R19	30%	16%	40%	–	13%	30%	43%	4/10		89%	11%	14%	–	30%	45%	75%	7/10
R19/F87A/A184I	51%	48%	14%	8%	12%	19%	31%	6/10		85%	54%	19%	–	13%	14%	27%	9/10
GVQ/V78L/I263G	28%	44%	56%	–	–	–	–	–		84%	28%	24%	–	20%	28%	48%	7/10
R19/F87A	53%	84%	11%	5%	–	–	–	–		89%	67%	12%	–	11%	11%	22%	10/10
GV/A184I	44%	54%	13%	23%	3%	7%	10%	5/10		92%	40%	8%	8%	18%	26%	45%	7/10
RT2	26%	18%	44%	–	10%	28%	38%	4/10		95%	10%	13%	-	31%	46%	77%	7/10

R19/F87A/I263G/A264G	24%	33%	67%	–	–	–	–	–	75%	40%	60%	–	–	–	–	–
RT2/V78I/A184I/A330P	41%	18%	15%	15%	21%	31%	52%	7/10	90%	27%	13%	–	26%	34%	60%	8/10
R19/F87A/G265GG	42%	50%	50%	–	–	–	–	–	85%	58%	42%	–	–	–	–	–
RP/H171L/I263G	75%	9%	3%	60%	11%	17%	28%	6/10	88%	38%	9%	17%	16%	20%	36%	8/10
RP/I263A/E267V	22%	33%	21%	-	21%	26%	47%	8/10	95%	17%	6%	–	32%	45%	77%	7/10
R19/S72W/F87A/A328I	49%	21%	15%	5%	23%	36%	59%	6/10	95%	23%	12%	–	30%	35%	65%	8/10
WT	25%	13%	57%	–	10%	20%	30%	5/10	76%	10%	0%	–	36%	54%	90%	7/10
GVQ/I263G	21%	43%	57%	–	–	–	–	–	67%	22%	15%	–	27%	36%	63%	8/10
GVQ/A264G	37%	63%	18%	–	5%	13%	19%	4/10	57%	52%	13%	–	15%	21%	35%	7/10
K19/F87V/A264G	36%	61%	20%	–	7%	12%	19%	6/10								
K19/V78I/F87V/E267V	35%	68%	32%	–	–	–	–	–	92%	45%	19%	–	15%	22%	36%	7/10
K19/A82M/F87A/E267F	25%	65%	35%	–	–	–	–	–	82%	44%	24%	–	13%	19%	32%	7/10
K19/A82M/F87A	29%	70%	16%	–	5%	8%	14%	6/10	76%	31%	9%	–	25%	35%	60%	7/10
R19/F87A/A328L	30%	21%	30%	19%	11%	20%	30%	5/10	78%	10%	10%	49%	13%	18%	31%	8/10
R19/F87A/A264G/A328G	31%	49%	36%	–	4%	10%	15%	4/10	67%	19%	14%	–	25%	42%	67%	6/10
R19/V78I/F87A/A328I	33%	27%	43%	–	9%	21%	30%	4/10								
R19/F87I/L437LV	36%	54%	38%	–	3%	6%	9%	4/10	95%	16%	13%	–	27%	43%	70%	6/10
GVQ/A330W	51%	69%	12%	5%	6%	8%	14%	7/10	87%	43%	10%	–	19%	29%	48%	6/10
R19/F87A/I263G	29%	56%	38%	7%	–	–	–	–	77%	34%	13%	–	23%	30%	53%	8/10
GVQ/A82M/I263G	19%	72%	28%	–	–	–	–	–	48%	44%	21%	–	11%	24%	34%	4/10
RP/A82M/I263A	24%	63%	18%	–	5%	14%	19%	4/10	59%	20%	7%	–	29%	45%	74%	6/10
RP/F87V	45%	51%	10%	20%	6%	12%	18%	5/10								
RP/V78I/F87V	31%	31%	0%	–	24%	45%	69%	5/10	95%	14%	3%	–	33%	51%	83%	6/10
I263G	19%	14%	86%	–	–	–	–	–	83%	7%	15%	8%	28%	42%	70%	7/10
GVQ/I263G/A328L	29%	7%	6%	87%	–	–	–	–	68%	–	4%	96%	–	–	–	–
R19/F87A/A328G/P329G/A330G	42%	73%	27%	–	–	–	–	–	81%	41%	15%	–	18%	25%	44%	7/10
RP/V78I/E267V	55%	58%	10%	12%	8%	13%	20%	6/10	70%	42%	8%	–	20%	30%	49%	7/10
R19/I263A/A328L	48%	6%	8%	86%	–	–	–	–	5%	100%	–	–	–	–	–	–

Appendix 3.3: *N*-phenyl piperidine (**7**) by the TFA1 and TFB plates.

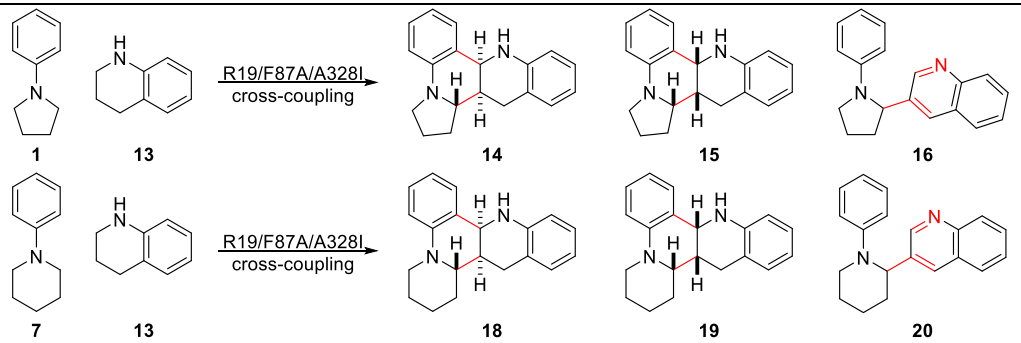


7 → **2** K19/F87V/Q403P 12% TON 230; **8** RP/E267G 100% TON 600; **9** K19/F87V/A328I 98% TON 4,410; **10** RP/E267V 58% TON 2,120; **11** F87A 25% TON 1,060; **12** RP/F87V/E267V/L437LV 8% TON 300

Mutant (*2000 : 1*)	**conv.**	**2**	**8**	**9**	**10**	**11**	**12**	**dimers**	**10 : 11**	***5000 : 1***	**conv.**	**8**	**9**	**10**	**11**	**12**	**dimers**	**10 : 11**
R19/F87A/A328I	100%	5%	–	25%	47%	21%	2%	70%	10/5		92%	5%	31%	41%	20%	3%	64%	10/5
K19/A82M/F87A	90%	–	1%	13%	48%	35%	2%	86%	10/7		88%	4%	54%	28%	13%	1%	42%	10/5
K19/Y51L/F87A/A328I	100%	–	–	61%	25%	12%	2%	39%	10/5		74%	6%	37%	37%	14%	6%	57%	10/4
K19/F87A/A184I/A328I	100%	2%	–	20%	42%	24%	2%	69%	10/6		52%	0%	86%	9%	4%	–	14%	10/5
RP/F87V/E267V/L437VL	74%	–	12%	–	52%	33%	2%	88%	10/6		71%	9%	20%	42%	18%	6%	66%	10/4
K19/F87A/I263A	69%	8%	–	23%	27%	18%	–	45%	10/7		51%	6%	52%	30%	11%	1%	42%	10/4
RP	96%	5%	2%	18%	30%	16%	1%	47%	10/5		88%	19%	32%	31%	16%	2%	49%	10/5
RP/E267V	98%	4%	3%	–	58%	32%	3%	92%	10/6		73%	8%	11%	58%	24%	–	81%	10/4
RT2/F81W	100%	–	4%	24%	34%	20%	2%	55%	10/6		74%	21%	34%	29%	14%	1%	45%	10/5
K19/F87V/Q403P	96%	12%	7%	31%	26%	3%	–	29%	10/1		71%	15%	80%	3%	2%	–	5%	10/4
K19/F87V/A328I	96%	–	–	91%	7%	2%	–	9%	10/3		90%	–	98%	2%	1%	–	2%	10/4
RP/F87V/E267V/L437LV	73%	2%	6%	10%	47%	33%	2%	82%	10/7		75%	13%	32%	36%	12%	8%	56%	10/3
F87A	95%	–	4%	16%	40%	24%	2%	66%	10/6		85%	7%	12%	53%	25%	4%	81%	10/5
RT2/A330P/I401M	98%	–	–	29%	37%	23%	2%	63%	10/6		86%	7%	48%	27%	15%	1%	42%	10/6
RT2/A82M/A330P	91%	–	3%	86%	8%	3%	–	11%	10/4		87%	2%	96%	1%	1%	–	2%	10/4
K19/F87A/I263A/A328I	83%	7%	–	24%	32%	14%	1%	48%	10/4		71%	1%	50%	30%	16%	1%	47%	10/5
RT2/A330P	98%	–	–	32%	27%	17%	1%	45%	10/6		86%	5%	43%	31%	17%	1%	50%	10/5
RT2/A184I/A330P	100%	–	–	75%	13%	7%	–	20%	10/5		91%	1%	86%	7%	4%	–	11%	10/5
RT2/V78I/A330P	98%	–	3%	15%	47%	33%	3%	82%	10/7		88%	7%	29%	39%	24%	2%	64%	10/6

RT2	100%	–	15%	29%	20%	12%	2%	35%	10/6	75%	34%	27%	26%	11%	2%	39%	10/4
RP/I263A/E267V	89%	5%	–	–	58%	34%	2%	95%	10/6	74%	6%	36%	37%	20%	1%	58%	10/5
WT	24%	–	79%	–	14%	7%	–	21%	10/5	44%	41%	40%	15%	5%	–	20%	10/3
RP/A330P	85%	–	2%	37%	32%	21%	–	52%	10/6	74%	9%	63%	16%	8%	–	24%	10/5
RP/F87V	97%	3%	22%	42%	10%	4%	–	13%	10/4	87%	6%	88%	5%	2%	–	6%	10/4
A330P	80%	–	14%	73%	9%	3%	1%	13%	10/3	80%	10%	57%	22%	9%	–	31%	10/4
RP/F81W	70%	–	23%	43%	22%	10%	2%	34%	10/5	77%	14%	44%	27%	14%	1%	42%	10/5
RP/H171L/A184I/I263G	80%	–	11%	74%	6%	1%	2%	10%	10/2	77%	5%	50%	28%	14%	–	42%	10/5
RP/H171L/I263G	92%	–	–	92%	5%	3%	–	8%	10/5	87%	1%	90%	6%	3%	–	9%	10/5
RT2/P329V/A330P	72%	–	25%	71%	–	–	–	–	–	90%	19%	73%	3%	2%	–	5%	10/5
GVQ	80%	–	19%	37%	31%	7%	7%	44%	10/2	86%	6%	18%	52%	22%	2%	75%	10/4
RT2/A330W	65%	–	37%	22%	27%	8%	5%	41%	10/3	75%	16%	16%	44%	22%	2%	68%	10/5
R19/F87A	66%	–	23%	29%	32%	7%	10%	49%	10/2	70%	–	20%	52%	24%	4%	80%	10/5
RP/A82M/I263A	33%	–	16%	84%	–	–	–	–	–	46%	18%	67%	11%	5%	–	16%	10/5
RP/F87V/H171L/I263G	69%	–	–	100%	–	–	–	–	–	85%	2%	93%	4%	2%	–	6%	10/5
RP/E267I	55%	–	42%	32%	18%	6%	2%	26%	10/3	67%	36%	28%	25%	11%	–	36%	10/5
K19/A82M/F87A/E267F	19%	–	–	70%	22%	5%	3%	30%	10/2	36%	3%	40%	37%	20%	–	57%	10/5
RP/H171L	77%	–	22%	31%	29%	13%	3%	44%	10/4	63%	11%	29%	40%	20%	–	60%	10/5
RP/E267G	14%	–	53%	47%	–	–	–	–	–	12%	100%	–	–	–	–	–	–
KSK48	25%	–	37%	41%	17%	4%	–	22%	10/3	25%	38%	37%	19%	6%	–	25%	10/3
K19/F87V/Q403P	73%	–	22%	66%	8%	3%	1%	12%	10/4	79%	21%	69%	7%	3%	–	10%	10/5
RT2/V78I/A184I/A330P	91%	–	7%	69%	15%	7%	2%	24%	10/5	85%	3%	67%	19%	11%	–	29%	10/6
RP/F87V/L188Q/E267V	87%	7%	11%	52%	20%	6%	3%	30%	10/3	80%	5%	23%	49%	22%	–	72%	10/5
RP/V78F/F87V/E267V	54%	–	19%	51%	19%	8%	2%	30%	10/4	65%	17%	35%	32%	16%	–	48%	10/5
RT2/F81W/A328I	71%	–	9%	59%	16%	5%	5%	26%	10/3	77%	2%	46%	30%	17%	–	47%	10/6
RP/E267M	17%	–	30%	18%	38%	8%	6%	52%	10/2	88%	1%	–	4%	1%	–	5%	10/4
K19/F87A/I263A/A328I	60%	–	9%	66%	17%	5%	3%	25%	10/3	71%	5%	52%	28%	14%	1%	44%	10/5
RT2/S72W/A330W	49%	–	45%	22%	22%	6%	4%	32%	10/3	70%	36%	17%	30%	15%	1%	47%	10/5

Appendix 3.4: *N*-phenyl pyrrolidine/piperidine (**1**/**7**) and 1,2,3,4-tetrahydroquinoline (**13**) by the TFA/A1 and TFB plates.

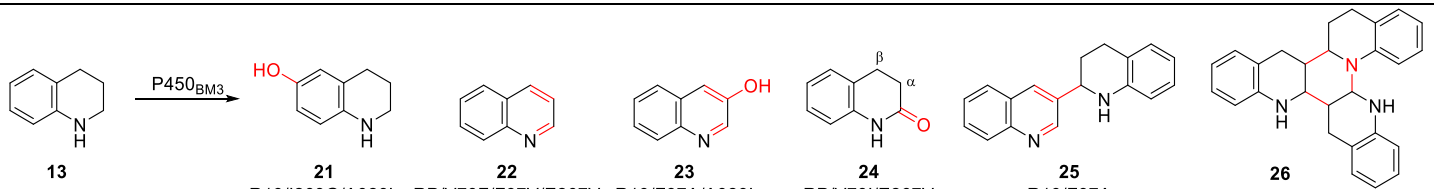


Mutant name (**1** & **13**)	conv.	14	15	16	14:15	others
R19/F87A/A328I	95%	31%	45%	1%	7/10	22%
K19/A82M/F87A	77%	27%	41%	1%	6/10	31%
K19/Y51L/F87A/A328I	91%	28%	44%	1%	6/10	27%
K19/F87A/A184I/A328I	94%	28%	41%	2%	7/10	30%
RP/F87V/E267V/L437VL	96%	19%	36%	1%	5/10	44%
KSK19/I263A	7%	26%	40%	0%	6/10	34%
RP	97%	19%	32%	1%	6/10	48%
RP/E267V	74%	16%	26%	1%	6/10	56%
RT2/F81W	66%	8%	15%	1%	6/10	76%
RP/F87V/E267V	46%	21%	42%	1%	5/10	36%
K19/F87V/A328I	97%	23%	38%	1%	6/10	38%
RP/F87V/E267V/L437LV	97%	24%	42%	1%	6/10	33%
K19 /V78I/F87A/A328I	2%	38%	62%	0%	6/10	0%
RT2/A330P/I401M	66%	21%	37%	1%	6/10	40%
RT2/A82M/A330P	81%	16%	35%	1%	5/10	48%
RT2/I401P	32%	30%	37%	2%	8/10	31%
RT2/A330P	73%	16%	26%	1%	6/10	57%
RT2/A184I/A330P	84%	19%	30%	1%	6/10	49%
RT2/V78I/A330P	91%	19%	29%	1%	7/10	51%

Mutant name (**7** & **13**)	conv.	18	19	20	18:19	others
R19/F87A/A328I	95%	10%	14%	3%	8/10	73%
K19/A82M/F87A	89%	8%	8%	2%	9/10	82%
K19/Y51L/F87A/A328I	91%	10%	16%	1%	6/10	73%
K19/F87A/A184I/A328I	77%	7%	12%	2%	6/10	79%
R19/F87V/E267V/L437VL	58%	9%	14%	4%	6/10	73%
K19/F87A/I263A	4%	0%	0%	0%		100%
RP	71%	5%	7%	0%	7/10	88%
RP/E267V	53%	0%	0%	0%		100%
RT2/F81W	59%	3%	0%	0%		97%
K19/F87V/Q403P	79%	6%	8%	3%	7/10	84%
K19/F87V/A328I	85%	1%	2%	1%	7/10	96%
RP/F87V/E267V/L437LV	82%	8%	11%	2%	7/10	80%
F87A	85%	11%	13%	0%	8/10	76%
RT2/A330P/I401M	79%	6%	7%	4%	8/10	83%
RT2/A82M/A330P	78%	0%	3%	0%		97%
K19/F87A/I263A/A328I	74%	5%	7%	2%	8/10	86%
RT2/A330P	87%	5%	6%	4%	8/10	85%
RT2/A184I/A330P	91%	4%	5%	2%	8/10	89%
RT2/V78I/A330P	81%	5%	6%	5%	8/10	85%

RT2	68%	10%	16%	1%	6/10	73%	RT2	59%	3%	3%	0%	10/10	94%
RP/I263A/E267V	45%	19%	32%	1%	6/10	48%	RP/I263A/E267V	47%	6%	7%	3%	8/10	84%
WT	6%	11%	17%	0%	6/10	72%	WT	22%	0%	0%	0%		100%
RP/A330P	93%	25%	39%	1%	6/10	34%	RP/A330P	87%	8%	12%	2%	7/10	78%
RP/F87V	90%	24%	38%	1%	6/10	37%	RP/F87V	93%	5%	1%	0%	35/10	93%
A330P	37%	19%	27%	1%	7/10	53%	A330P	65%	3%	5%	3%	6/10	90%
RP/F81W	83%	13%	20%	1%	6/10	66%	RP/F81W	63%	3%	3%	2%	11/10	92%
RT2/S72A/A328I/A330P	91%	9%	14%	0%	6/10	77%	RP/H171L/A184I/I263G	72%	3%	4%	3%	7/10	90%
RP/H171L/I263G	97%	12%	19%	1%	6/10	69%	RP/H171L/I263G	78%	0%	2%	2%		96%
RT2/P329V/A330P	96%	10%	17%	1%	6/10	72%	RT2/P329V/A330P	84%	2%	3%	0%	7/10	95%
GVQ	85%	26%	43%	1%	6/10	30%	GVQ	20%	0%	11%	0%		89%
RT2/A330W	69%	12%	21%	1%	6/10	66%	RT2/A330W	56%	7%	9%	2%	8/10	83%
F87A	5%	24%	39%	0%	6/10	37%	F87A	5%	0%	0%	0%		100%
R19/F87A	19%	27%	46%	0%	6/10	26%	R19/F87A	66%	7%	11%	2%	7/10	79%
RP/A82M/I263A	46%	12%	22%	1%	6/10	65%	RP/A82M/I263A	44%	3%	3%	0%	9/10	93%
RT2/V78F	69%	22%	32%	1%	7/10	45%	RP/F87V/H171L/I263G	87%	3%	4%	1%	7/10	92%
R47L/Y51F	51%	23%	35%	2%	7/10	40%	RP/E267I	38%	0%	0%	0%		100%
K19/A82M/F87A/E267F	58%	16%	25%	2%	7/10	57%	K19/A82M/F87A/E267F	76%	7%	8%	3%	8/10	82%
RP/H171L	96%	14%	24%	1%	6/10	61%	RP/H171L	63%	7%	6%	1%	11/10	86%
RP/E267G	4%	19%	33%	0%	6/10	48%	RP/E267G	10%	0%	0%	0%		100%
KSK48	2%	0%	0%	0%		100%	KSK48	19%	0%	0%	0%		100%
K19/F87V/Q403P	74%	26%	42%	1%	6/10	31%	K19/F87V/Q403P	76%	5%	6%	1%	8/10	89%
RT2/V78I/A184I/A330P	94%	19%	32%	1%	6/10	48%	RT2/V78I/A184I/A330P	85%	3%	0%	4%		94%
RP/F87V/L188Q/E267V	87%	30%	47%	2%	6/10	21%	RP/F87V/L188Q/E267V	89%	7%	8%	4%	9/10	81%
RP/V78F/F87V/E267V	73%	28%	48%	2%	6/10	22%	RP/V78F/F87V/E267V	77%	4%	3%	5%	13/10	88%
RT2/F81W/A328I	96%	18%	29%	1%	6/10	51%	RT2/F81W/A328I	72%	3%	0%	3%		93%
RP/E267M	55%	18%	27%	1%	7/10	53%	RP/E267M	6%	0%	0%	0%		100%
K19/F87V/I263A/A328I	33%	32%	37%	2%	9/10	29%	K19/F87A/I263A/A328I	79%	7%	13%	2%	5/10	78%
RT2/S72W/A330W	94%	9%	15%	1%	6/10	75%	RT2/S72W/A330W	80%	6%	5%	0%	11/10	89%

Appendix 3.5: 1,2,3,4-tetrahydroquinoline (**13**) by the WY3/4 plates, the 2nd generation GVQ/IG-based and I263G/A328L variant library.



13

21 R19/I263G/A328L 79% TON 1,390 (WY3/4)

22 RP/V78F/F87V/E267V 94% TON 1,730 (TFA/B)

23 R19/F87A/A328I 14% TON 260 (WY3/4)

24 RP/V78I/E267V 20% TON 350 (WY3/4)

25 R19/F87A 60% TON 1,160 (WY3/4)

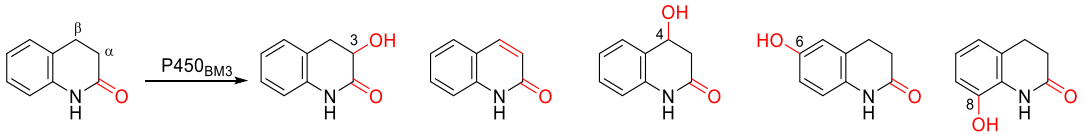
26 R19/F87A/A328I 4% TON <80

Variant library	Mutant	conversion	21	22	23	24	25
WY3	R19/A330W	19%	31%	35%	3%	13%	18%
	K19/F87A/I263G	57%	11%	25%	4%	7%	53%
	GVQ	3%	0%	82%	0%	0%	18%
	R19/F87I	20%	7%	27%	1%	2%	64%
	K19/F87V	69%	12%	18%	4%	18%	48%
	K19/F87V/E267V	77%	5%	33%	1%	14%	47%
	K19/A82M/F87A/I263G	7%	2%	58%	1%	4%	35%
	K19/F87V/A328V	89%	25%	13%	3%	4%	54%
	K19/F81W/F87A	55%	8%	23%	5%	3%	60%
	K19/F87A/I263A	5%	0%	60%	0%	0%	40%
	K19/F87V/Q403P	72%	7%	21%	4%	16%	51%
	KU3/A328I/A330P	92%	25%	16%	3%	4%	52%
	R19/A184I/A328L	99%	39%	12%	1%	0%	47%
	GVQ/I263G/A328L	62%	48%	12%	3%	3%	35%
	R19	52%	40%	18%	3%	8%	31%
	R19/F87A/A184I	91%	4%	20%	4%	13%	58%
	R19/F87A/A328I	99%	6%	16%	13%	4%	58%
	R19/F87A	97%	4%	17%	8%	10%	60%
	GV/A184I	91%	11%	16%	5%	15%	53%
	RT2	75%	37%	13%	5%	7%	38%

WY4	RT2/S72G/A330W	4%	11%	67%	0%	3%	19%
	RT2/V78I/A184I/A330P	92%	27%	17%	4%	4%	49%
	KU3/A330P	65%	17%	37%	3%	7%	37%
	RP/H171L/I263G	97%	54%	9%	6%	1%	31%
	RP/I263A/E267V	15%	23%	61%	0%	1%	15%
	GVQ/I263A/A328I	2%	0%	91%	0%	0%	9%
	WT	10%	31%	47%	5%	13%	3%
	GVQ/I263G	12%	0%	69%	0%	0%	31%
	GVQ/A264G	45%	17%	23%	4%	8%	48%
	K19/F87V/A264G	50%	10%	23%	4%	9%	54%
	K19/V78I/F87V/E267V	47%	4%	28%	2%	24%	42%
	K19/A82M/F87A/E267F	17%	0%	51%	0%	0%	49%
	K19/F87A/A82M	96%	4%	23%	5%	8%	58%
	R19/F87A/A328L	97%	11%	16%	8%	7%	59%
	R19/S72W/F87A/A328I	54%	6%	21%	4%	2%	67%
	R19/V78I/F87A/A328I	64%	8%	21%	14%	2%	54%
	R47L/Y51F/I263R	7%	17%	50%	5%	2%	27%
	R19/F87A/A328F	94%	11%	19%	12%	5%	51%
	R19/F87A/I263G	67%	11%	23%	5%	11%	51%
	RP/A82W/I263A	34%	16%	44%	2%	2%	36%
	RP/A82M/I263A	44%	47%	24%	5%	8%	16%
	RP/F87V	83%	5%	20%	5%	19%	51%
	RP/V78I/F87V	30%	13%	37%	4%	2%	45%
	RP/H171L/A184I/I263G	64%	51%	15%	4%	4%	27%
	R19/I263G/A328L	88%	79%	14%	3%	0%	4%
	RP/V78I/F87V/H171L/I263G	59%	18%	19%	4%	14%	45%
	RP/V78I/E267V	87%	7%	20%	6%	20%	47%
	RT2/S72W/A330W	44%	51%	19%	2%	12%	16%
	GVQ/I263G	22%	7%	50%	0%	7%	36%

The 2nd generation GVQ/I263G-based variant library	GVQ/I263G/A328L	4%	0%	100%	0%	0%	0%
	GVQ/I263G/A328F	83%	7%	19%	34%	0%	41%
	GVQ/I263G/A328I	13%	32%	38%	0%	0%	30%
	GAQ/I263G (F87A)	11%	10%	49%	0%	16%	25%
	GAQ/I263G/A328G	7%	9%	49%	0%	0%	34%
	GAQ/I263G/A328L	32%	25%	20%	0%	8%	46%
	GLQ/I263G (F87L)	19%	7%	62%	0%	13%	19%
	GLQ/I263G/A328I	0%					
	GLQ/I263G/A328G	10%	21%	42%	0%	22%	14%
	GLQ/I263G/A328L	22%	0%	26%	58%	0%	16%
	GLQ/I263G/A328F	20%	0%	23%	61%	0%	16%
	GGQ (F87G)	12%	18%	45%	0%	0%	37%
	GGQ/I263G/A328F	5%	0%	62%	0%	0%	38%
	GGQ/I263G/A328G	16%	0%	69%	0%	0%	31%
	GGQ/I263G/A328L	21%	26%	25%	0%	4%	45%
The 2nd generation I263G/A328L variant library	R19	52%	40%	18%	3%	8%	31%
	R19/A328L*	100%	60%	13%	0%	0%	26%
	R19/I263G*	100%	85%	4%	0%	0%	12%
	R19/I263G/A328L	88%	79%	14%	3%	0%	4%
	RP/H171L	93%	33%	54%	0%	1%	10%
	RP/H171L/I263G	97%	54%	9%	6%	1%	31%
	RP/H171L/I263G/A328L*	100%	84%	10%	0%	0%	6%
	R19/F87A/A328L	100%	6%	12%	3%	5%	62%
	R19/F87A/I263G	100%	5%	46%	3%	4%	31%
	R19/F87A/I263G/A328L*	100%	28%	40%	6%	0%	23%

Appendix 3.6: 3,4-dihydro-2-quinolinone (**24**) by the WY3/4 plates and the 2nd generation variant library.



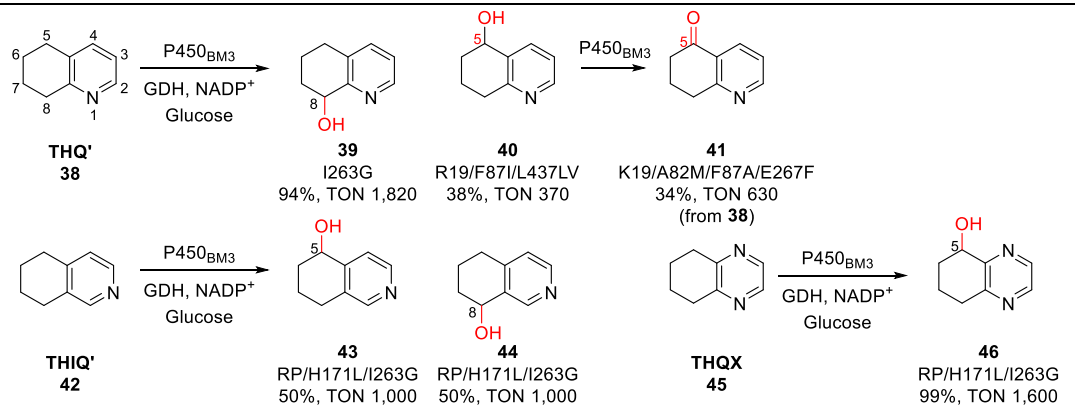
24 | **32** RP/H171L/I263G 6% TON 80 | **33** R19/F87A/A328I 65% TON 530 | **34** RT2/V78I/A184I/A330P 76% TON 670 | **35** R19/I263G/A328L 100% TON 520 | **36** RT2/S72H/A330W 50% TON 700

Variant library	Mutant	conv.	32	33	34	35	36
WY3	R19/A330W	0%					
	K19/F87A/I263G	3%		58%	42%		
	GVQ	0%					
	R19/F87I	0%					
	K19/F87V	26%		55%	45%		
	K19/F87V/E267V	4%		52%	48%		
	K19/A82M/F87A/I263G	1%		66%	34%		
	K19/F87V/A328V	32%		55%	45%		
	K19/F81W/F87A	5%		56%	44%		
	K19/F87A/I263A	0%					
	K19/F87V/Q403P	13%		56%	44%		
	KU3/A328I/A330P	2%		47%	53%		
	R19/A184I/A328L	1%		53%	29%	18%	
	GVQ/I263G/A328L	0%					
	R19	18%		25%	37%	16%	23%
	R19/F87A/A184I	32%		59%	41%		
	R19/F87A/A328I	41%		65%	35%		
	R19/F87A	34%		63%	37%		
	GV/A184I	20%		48%	45%		7%
	RT2	38%		26%	40%	13%	21%
	RT2/S72G/A330W	0%					
	RT2/V78I/A184I/A330P	44%		15%	76%	2%	7%

WY4	KU3/A330P	42%		13%	60%	2%	25%
	RP/H171L/I263G	66%	6%	19%	27%	48%	
	RP/I263A/E267V	6%		36%	47%	17%	
	GVQ/I263A/A328I	0%					
	WT	0%					
	GVQ/I263G	0%					
	GVQ/A264G	4%		48%	52%		
	K19/F87V/A264G	3%		39%	61%		
	K19/V78I/F87V/E267V	12%		55%	45%		
	K19/A82M/F87A/E267F	6%		62%	38%		
	K19/A82M/F87A	44%		52%	48%		
	R19/F87A/A328L	21%		65%	35%		
	R19/S72W/F87A/A328I	17%		68%	32%		
	R19/V78I/F87A/A328I	8%		73%	27%		
	R47L/Y51F/I263R	0%					
	R19/F87A/A328F	6%		54%	46%		
	R19/F87A/I263G	19%		65%	35%		
	RP/A82W/I263A	6%	15%	36%	49%		
	RP/A82M/I263A	32%	9%	22%	39%	30%	
	RP/F87V	11%		56%	44%		
	RP/V78I/F87V	30%		31%	53%	6%	10%
	RP/H171L/A184I/I263G	31%	2%	29%	41%	28%	
	R19/I263G/A328L	26%				100%	
	RP/V78I/F87V/H171L/I263G	14%		48%	52%		
	RP/V78I/E267V	19%		55%	45%		
	RT2/S72W/A330W	12%		33%	54%		13%
The 2nd generation variant library	RT2/A330W	7%		11%	36%	15%	38%
	RT2/S72R/A330W	1%		25%	30%	4%	40%
	RT2/S72L/A330W	1%		27%	29%		44%
	RT2/S72H/A330W	70%		6%	38%	6%	50%

	RT2/S72Y/A330W	66%		9%	44%	7%	39%
	RT2/S72V/A330W	7%		14%	38%	25%	22%
	R19/I263A/A328L	60%	1%	5%	6%	87%	1%

Appendix 3.7: THQ' (**38**), THIQ' (**42**), and THQX (**45**) by the WY7/8 plates.

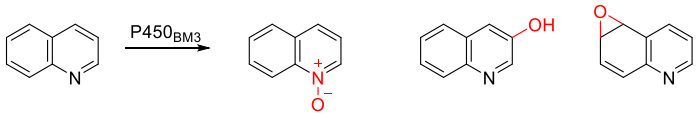


Mutant	THQ' (38)				THIQ' (43)		THQX (46)	
	Conv.	39	40	41	Conv.	43 & 44	Conv.	46
R19/A330W	37%	90%	9%	1%			4%	100%
K19/F87A/I263G	26%	85%	8%	3%			1%	100%
GVQ	96%	72%	11%	6%			19%	91%
R19/F87I	95%	59%	28%	2%			8%	89%
K19/F87V	98%	72%	9%	8%	2%	100%	43%	92%
K19/F87V/E267V	100%	73%	8%	6%	2%	100%	21%	90%
K19/A82M/F87A/I263G	6%	83%	17%	0%			0%	100%
K19/F87V/A328V	96%	89%	5%	2%			24%	98%
K19/F81W/F87A	34%	68%	18%	3%			2%	100%
K19/F87A/I263A	5%	78%	16%	0%			0%	
K19/F87V/Q403P	83%	75%	12%	2%			29%	87%
KU3/A328I/A330P	61%	85%	15%	0%			5%	100%
R19/A184I/A328L	26%	83%	9%	0%			3%	100%
R19/F87A/A328G	36%	68%	24%	3%			1%	100%
R19	84%	90%	8%	1%			16%	100%
R19/F87A/A184I	96%	52%	7%	28%	2%	100%	20%	93%

GVQ/V78L/I263G	56%	74%	23%	0%			3%	100%
R19/F87A	86%	60%	19%	8%			5%	100%
GV/A184I	61%	79%	13%	0%			7%	90%
RT2	94%	90%	7%	2%			21%	100%
R19/F87A/I263G/A264G	23%	82%	10%	5%			0%	
RT2/V78I/A184I/A330P	96%	89%	6%	5%	5%	100%	52%	100%
R19/F87A/G265GG	0%						0%	
RP/H171L/I263G	95%	76%	0%	19%	100%	100%	80%	99%
RP/I263A/E267V	100%	93%	3%	2%	72%	100%	66%	100%
R19/S72W/F87A/A328I	100%	77%	15%	3%			70%	98%
WT	10%	92%	8%	0%			3%	100%
GVQ/I263G	82%	83%	13%	1%			8%	100%
GVQ/A264G	70%	69%	14%	1%			6%	74%
K19/F87V/A264G	62%	69%	14%	1%			4%	76%
K19/V78I/F87V/E267V	100%	66%	5%	11%	5%	100%	55%	91%
K19/A82M/F87A/E267F	100%	52%	4%	34%	4%	100%	35%	85%
K19/A82M/F87A	97%	54%	7%	29%	1%	100%	30%	94%
R19/F87A/A328L	100%	77%	7%	4%	1%	100%	65%	95%
R19/F87A/A264G/A328G	9%	76%	14%	0%	1%	100%	1%	100%
R19/V78I/F87A/A328I	98%	74%	10%	4%	2%	100%	28%	95%
R19/F87I/L437LV	49%	54%	38%	1%			2%	100%
GVQ/A330W	98%	60%	16%	7%			39%	89%
R19/F87A/I263G	85%	77%	7%	12%	6%	100%	7%	92%
GVQ/A82M/I263G	23%	68%	25%	0%			1%	100%
RP/A82M/I263A	78%	88%	7%	6%			14%	100%
RP/F87V	3%	81%	19%	0%	1%	100%	7%	92%
RP/V78I/F87V	99%	91%	6%	2%	53%	100%	32%	100%
I263G	97%	94%	2%	4%			12%	100%
GVQ/I263G/A328L	0%						0%	
R19/F87A/A328G/P329G/A330G	11%	67%	25%	0%			0%	

RP/V78I/E267V	82%	66%	20%	3%		2%	100%	10%	89%
R19/I263A/A328L	34%	72%	11%	0%				0%	

Appendix 3.8: Quinoline (**22**) by the WY1/2 plates.

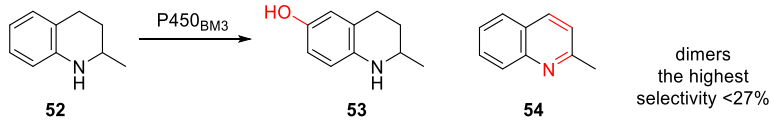


22 | **47** R19/F87A/E267F/A328I 99%, TON 1,580 | **23** RP/V78I/F87V 9% TON 70 | **48** KU3/A330P 97% TON 1,010

Mutant	Conv.	47	23	48
A330P	6%			100%
A82T/I263R	0%			
GVQ	0%			
K19	0%			
K19/F87V	37%	65%		34%
K19/F87V/E267V	21%	60%	3%	33%
K19/A82M/F87A/I263G	4%	48%		50%
K19/F87V/A328I	79%	91%		
K19/F81W/F87A	14%	95%		3%
K19/F87A/I263A	0%			
K19/F87V/Q403P	34%	72%		24%
KU3/A328I/A330P	1%			100%
KU3/S72W/A330P	48%			97%
KU3/V78I/A330P	19%			99%
R19	2%			100%
R19/F87A/A184I	29%	86%		5%
R19/F87A/A328I	77%	98%		
R19/F87A	18%	77%		
RP/H171L	68%	3%	4%	89%
RT2	12%			100%
RT2/S72G/A330W	0%			0%
RT2/V78I/A184I/A330P	51%			94%
KU3/A330P	52%			97%
RP/H171L/I263G	64%		3%	79%
A82M/A330P	13%			100%
I263A/A330P	0%			
F81W/T260A	0%			
GV/A184I	17%	69%		31%
GVQ/A264G	1%	100%		
K19/F87V/A264G	2%	100%		
K19/V78I/F87V/E267V	22%	67%		32%
K19/A82M/F87A/E267F	62%	69%	3%	24%
R19/F87A/E267F/A328I	80%	99%		
R19/F87A/A328L	78%	99%		
R19/S72W/F87A/A328I	2%	100%		
R19/V78I/F87A/A328I	3%	100%		
R47L/Y51F/I263R	9%			100%
R19/F87A/A328F	16%	99%		
R19/F87A/I263G	25%	2%	9%	81%

RP/A82W/I263A	12%			86%
RP/A82M/I263A	10%	0%		84%
RP/F87V	29%	54%	4%	37%
RP/V78I/F87V	41%	3%	9%	86%
RP/H171L/A184I/I263G	33%	1%	6%	86%
RT2/H171L/I263G/A330W	2%			100%
RP/V78I/F87V/H171L/I263G	47%			92%
RP/V78I/E267V	19%	70%		29%
RT2/S72W/A330W	10%			100%

Appendix 3.9: 2Me-THQ (**52**) by the WY3/4 plates.



52 2MTHQ

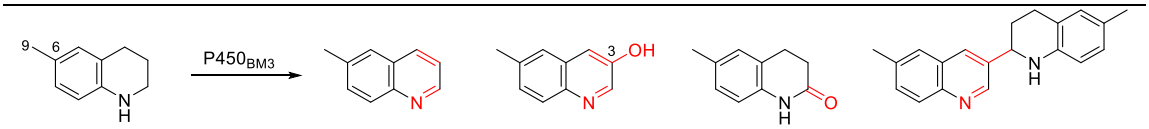
53 R19/A184I/A328L 99%, TON 1,940

54 K19/A82M/F87A/E267F 60%, TON 380

Mutant	Conv.	53	54	dimers (minor)
R19/A330W	25%	85%	15%	
K19/F87A/I263G	48%	43%	45%	13%
GVQ	59%	56%	36%	7%
R19/F87I	19%	78%	16%	6%
K19/F87V	77%	92%	5%	3%
K19/F87V/E267V	49%	89%	9%	2%
K19/A82M/F87A/I263G	20%	43%	57%	1%
K19/F87V/A328V	89%	83%	13%	4%
K19/F81W/F87A	84%	70%	22%	8%
K19/F87A/I263A	21%	47%	43%	10%
K19/F87V/Q403P	78%	93%	5%	2%
KU3/A328I/A330P	74%	93%	5%	2%
R19/A184I/A328L	98%	99%	1%	
GVQ/I263G/A328L	61%	94%	4%	3%
R19	79%	94%	6%	
R19/F87A/A184I	92%	79%	13%	8%
R19/F87A/A328I	91%	47%	31%	22%
R19/F87A	97%	71%	17%	12%
GV/A184I	83%	95%	2%	3%
RT2	65%	94%	6%	
RT2/S72G/A330W	6%	86%	14%	
RT2/V78I/A184I/A330P	86%	98%	2%	
KU3/A330P	51%	93%	7%	
RP/H171L/I263G	96%	96%	4%	
RP/I263A/E267V	26%	92%	8%	
GVQ/I263A/A328I	1%	57%	43%	
WT	23%	86%	12%	2%
GVQ/I263G	2%	44%	56%	
GVQ/A264G	52%	92%	7%	1%
K19/F87V/A264G	66%	90%	8%	2%
K19/V78I/F87V/E267V	29%	83%	12%	5%
K19/A82M/F87A/E267F	32%	31%	60%	9%
K19/A82M/F87A	85%	75%	20%	4%
R19/F87A/A328L	84%	85%	9%	5%
R19/S72W/F87A/A328I	96%	50%	47%	4%
R19/V78I/F87A/A328I	88%	42%	32%	26%
R47L/Y51F/I263R	9%	73%	27%	
R19/F87A/A328F	83%	94%	6%	
R19/F87A/I263G	63%	50%	31%	19%

RP/A82W/I263A	31%	75%	25%	
RP/A82M/I263A	38%	85%	14%	1%
RP/F87V	91%	93%	4%	2%
RP/V78I/F87V	41%	91%	9%	
RP/H171L/A184I/I263G	88%	94%	5%	1%
R19/I263G/A328L	93%	98%	2%	
RP/V78I/F87V/H171L/I263G	67%	68%	20%	13%
RP/V78I/E267V	93%	89%	7%	4%
RT2/S72W/A330W	60%	89%	10%	

Appendix 3.10: 6Me-THQ (**56**) by the WY3/4 plates.

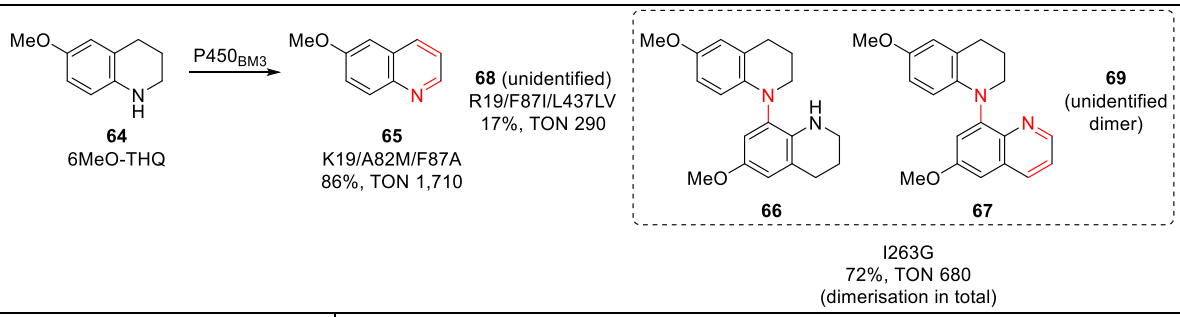


56 6MTHQ | **57** RP/V78I/F87V 72%, TON 700 | **58** K19/A82M/F87A 27%, TON 320 | **59** K19/F87V/E267V 22%, TON 430 | **60** RT2 38%, TON 700

Mutant	conversion	57	58	59	60
R19/A330W	5%	100%			
K19/F87A/I263G	6%	100%			
GVQ	3%	100%			
R19/F87I	4%	100%			
K19/F87V	88%	36%	15%	19%	29%
K19/F87V/E267V	96%	40%	6%	22%	30%
K19/A82M/F87A/I263G	5%	100%			
K19/F87V/A328V	51%	62%	14%		23%
K19/F81W/F87A	18%	67%	11%		21%
K19/F87A/I263A	5%	86%	7%		7%
K19/F87V/Q403P	92%	37%	10%	18%	33%
KU3/A328I/A330P	26%	80%	9%		12%
R19/A184I/A328L	32%	81%	8%		11%
GVQ/I263G/A328L	8%	100%			
R19	61%	48%	14%	6%	31%
R19/F87A/A184I	54%	50%	19%	3%	27%
R19/F87A/A328I	34%	49%	23%		29%
R19/F87A	76%	45%	16%	2%	37%
GV/A184I	96%	50%	12%	9%	28%
RT2	92%	48%	3%	11%	38%
RT2/S72G/A330W	3%	100%			
RT2/V78I/A184I/A330P	27%	67%	4%		28%
KU3/A330P	18%	88%			12%
RP/H171L/I263G	28%	93%			7%
RP/I263A/E267V	12%	100%			
GVQ/I263A/A328I	2%	100%			
WT	21%	69%		12%	19%
GVQ/I263G	3%	100%			
GVQ/A264G	31%	60%	9%		31%
K19/F87V/A264G	88%	46%	16%	1%	37%
K19/V78I/F87V/E267V	95%	42%	19%	4%	33%
K19/A82M/F87A/E267F	20%	75%	10%		15%
K19/A82M/F87A	58%	43%	27%	2%	29%
R19/F87A/A328L	74%	34%	24%	7%	34%
R19/S72W/F87A/A328I	10%	82%			18%
R19/V78I/F87A/A328I	21%	52%	17%		30%
R47L/Y51F/I263R	2%	100%			
R19/F87A/A328F	16%	56%	8%		36%
R19/F87A/I263G	18%	63%	12%		25%
RP/A82W/I263A	9%	100%			
RP/A82M/I263A	7%	100%			
RP/F87V	89%	38%	13%	12%	35%
RP/V78I/F87V	48%	72%	4%	1%	24%
RP/H171L/A184I/I263G	27%	94%			6%
R19/I263G/A328L	4%	100%			
RP/V78I/F87V/H171L/I263G	28%	66%	9%		25%

RP/V78I/E267V	90%	34%	16%	11%	38%
RT2/S72W/A330W	34%	71%	2%	15%	12%

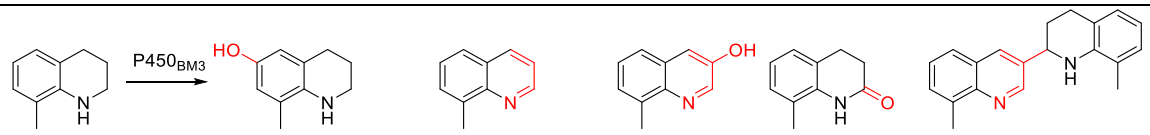
Appendix 3.11: 6MeO-THQ (**56**) by the WY7/8 plates.



Mutant	conversion	65	66	67	68	69	dimers
R19/A330W	18%	18%	37%	4%	25%	15%	57%
K19/F87A/I263G	13%	82%	5%	5%	7%		10%
GVQ	40%	51%	22%	12%	10%	6%	39%
R19/F87I	28%	26%	36%	7%	17%	13%	56%
K19/F87V	68%	57%	10%	9%	11%	1%	20%
K19/F87V/E267V	34%	68%	19%	9%		4%	32%
K19/A82M/F87A/I263G	59%	89%	6%	4%		1%	11%
K19/F87V/A328V	31%	68%	9%	10%	12%	1%	20%
K19/F81W/F87A	87%	83%	7%	7%	3%		14%
K19/F87A/I263A	3%	100%					0%
K19/F87V/Q403P	47%	39%	31%	14%	9%	7%	52%
KU3/A328I/A330P	6%	52%			48%		
R19/A184I/A328L	11%	83%			17%		
R19/F87A/A328G	93%	81%	9%	7%	4%		15%
R19	29%	10%	64%			26%	90%
R19/F87A/A184I	95%	88%	6%	6%			12%
GVQ/V78L/I263G	46%	55%	26%	9%	6%	5%	40%
R19/F87A	88%	66%	15%	13%	4%	2%	30%
GV/A184I	91%	87%	4%	4%	6%		8%
RT2	33%	10%	59%		7%	24%	83%
R19/F87A/I263G/A264G	6%	76%			24%		
RT2/V78I/A184I/A330P	58%	57%	4%	2%	12%	1%	8%
R19/F87A/G265GG	0%						
RP/H171L/I263G	62%	57%	6%	2%	12%	1%	9%
RP/I263A/E267V	32%	76%	8%	6%	10%		14%
R19/S72W/F87A/A328I	18%	90%			10%		
WT	6%	41%	59%				59%
GVQ/I263G	27%	100%					
GVQ/A264G	13%	69%	31%				31%
K19/F87V/A264G	28%	57%	20%		23%		20%
K19/V78I/F87V/E267V	51%	57%	28%	10%		6%	43%
K19/A82M/F87A/E267F	74%	88%	5%	7%			12%
K19/A82M/F87A	100%	86%	7%	8%			14%
R19/F87A/A328L	26%	80%			20%		
R19/F87A/A328G/A264G	35%	43%	35%		14%	8%	43%
R19/V78I/F87A/A328I	32%	23%	37%	6%	20%	15%	57%
R19/F87I/L437LV	88%	69%	9%	6%	17%		14%
GVQ/A330W	57%	48%	24%	11%	12%	5%	40%
R19/F87A/I263G	85%	76%	14%	11%			24%
GVQ/A82M/I263G	60%	86%	6%	6%		2%	14%
RP/A82M/I263A	25%	19%	45%	8%	9%	19%	72%
RP/F87V	70%	82%	6%	7%	4%		13%
RP/V78I/F87V	24%	65%	16%	7%	7%	5%	28%

I263G	47%	9%	47%	5%	18%	20%	72%
GVQ/I263G/A328L	2%	100%					
R19/F87A/A328G/P329G/A330G	86%	75%	10%	8%	5%	2%	20%
RP/V78I/E267V	64%	81%	6%	6%	7%		12%
R19/I263A/A328L	6%	100%					

Appendix 3.12: 8Me-THQ (**70**) by the WY1/2 plates.

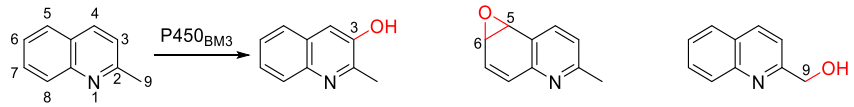


70 | **71** KU3/A328I/A330P 50%, TON 570 | **72** K19/F87V/E267V 80%, TON 1,520 | **73** R19/F87A/A328I 5%, TON 80 | **74** GV/A184I 19%, TON 270 | **75** K19/F81W/F87A 42%, TON 610

Mutant	Conv.	71	72	73	74	75
A330P	20%	34%	59%	0%	1%	6%
A82T/I263R	13%	28%	72%	0%	0%	0%
GVQ	17%	11%	73%	2%	0%	14%
K19	35%	36%	51%	0%	2%	11%
K19/F87V	82%	9%	33%	4%	15%	40%
K19/F87V/E267V	95%	3%	80%	0%	7%	10%
K19/A82M/F87A/I263G	15%	6%	75%	2%	0%	17%
K19/F87V/A328I	83%	35%	46%	1%	1%	17%
K19/F81W/F87A	73%	4%	39%	4%	11%	42%
K19/F87A/I263A	13%	3%	80%	0%	0%	16%
K19/F87V/Q403P	78%	9%	39%	3%	13%	36%
KU3/A328I/A330P	57%	50%	42%	0%	0%	8%
KU3/S72W/A330P	52%	45%	45%	0%	0%	9%
KU3/V78I/A330P	43%	37%	42%	0%	0%	21%
R19	47%	41%	44%	0%	2%	14%
R19/F87A/A184I	88%	9%	42%	0%	13%	36%
R19/F87A/A328I	82%	13%	52%	5%	6%	24%
R19/F87A	94%	11%	46%	2%	7%	34%
RP/H171L	72%	45%	37%	0%	2%	16%
RT2	56%	46%	39%	0%	2%	13%
RT2/S72G/A330W	5%	0%	100%	0%	0%	0%
RT2/V78I/A184I/A330P	64%	38%	42%	0%	1%	18%
KU3/A330P	46%	33%	48%	0%	0%	6%
RP/H171L/I263G	88%	47%	33%	3%	1%	12%
A82M/A330P	26%	46%	54%	0%	0%	0%
I263A/A330P	18%	35%	65%	0%	0%	0%
F81W/T260A	22%	32%	62%	0%	0%	6%
GV/A184I	70%	9%	33%	1%	19%	37%
GVQ/A264G	65%	7%	50%	3%	10%	19%
K19/F87V/A264G	72%	9%	48%	4%	8%	27%
K19/V78I/F87V/E267V	70%	5%	64%	1%	15%	13%
K19/A82M/F87A/E267F	94%	19%	39%	0%	0%	31%
R19/F87A/E267F/A328I	86%	25%	40%	4%	4%	28%
R19/F87A/A328L	83%	24%	38%	4%	4%	30%
R19/S72W/F87A/A328I	27%	22%	71%	1%	0%	5%
R19/V78I/F87A/A328I	30%	16%	76%	1%	2%	5%
R47L/Y51F/I263R	75%	48%	41%	3%	0%	9%
R19/F87A/A328F	86%	6%	54%	4%	12%	25%

R19/F87A/I263G	52%	5%	71%	0%	3%	21%
RP/A82W/I263A	24%	26%	74%	0%	0%	0%
RP/A82M/I263A	49%	54%	42%	0%	0%	5%
RP/F87V	69%	9%	37%	4%	10%	39%
RP/V78I/F87V	43%	22%	71%	0%	0%	7%
RP/H171L/A184I/I263G	81%	46%	42%	4%	0%	8%
RT2/H171L/I263G/A330W	58%	43%	47%	0%	1%	9%
RP/V78I/F87V/H171L/I263G	47%	6%	69%	1%	2%	22%
RP/V78I/E267V	71%	8%	43%	3%	10%	35%
RT2/S72W/A330W	56%	45%	40%	0%	2%	13%

Appendix 3.13: 2Me-Q (**54**) by the WY3/4 plates.



54
2MQ

81
RP/V78I/F87V/H171L/I263G
39%, TON 280

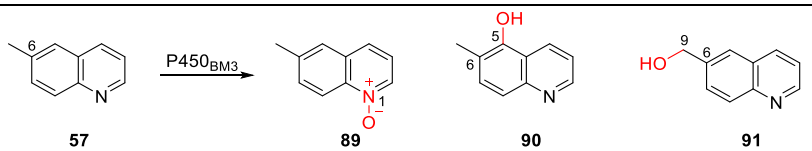
82
RP/H171L/I263G
77%, TON 1,390

83
K19/F87A/A82M
100%, TON 640

Mutant	Conv.	81	82	83
R19/A330W	0%			
K19/F87A/I263G	7%	5%	55%	39%
GVQ	0%			
R19/F87I	1%			100%
K19/F87V	20%		65%	35%
K19/F87V/E267V	8%			100%
K19/A82M/F87A/I263G	4%		42%	58%
K19/F87V/A328V	28%		2%	98%
K19/F81W/F87A	2%			100%
K19/F87A/I263A	0%			
K19/F87V/Q403P	5%		61%	39%
KU3/A328I/A330P	0%			
R19/A184I/A328L	9%			100%
GVQ/I263G/A328L	19%			100%
R19	0%			
R19/F87A/A184I	15%		33%	67%
R19/F87A/A328I	31%		0%	100%
R19/F87A	11%		21%	79%
GV/A184I	17%		50%	50%
RT2	16%	22%	78%	
RT2/S72G/A330W	0%			
RT2/V78I/A184I/A330P	34%	12%	47%	41%
KU3/A330P	8%	25%	60%	14%
RP/H171L/I263G	90%	1%	77%	22%
RP/I263A/E267V	11%	4%	42%	53%
GVQ/I263A/A328I	0%			
WT	0%			
GVQ/I263G	0%			
GVQ/A264G	0%			
K19/F87V/A264G	10%	5%	75%	20%
K19/V78I/F87V/E267V	18%		35%	65%
K19/A82M/F87A/E267F	30%			100%
K19/A82M/F87A	32%			100%
R19/F87A/A328L	20%			100%
R19/S72W/F87A/A328I	0%			
R19/V78I/F87A/A328I	0%			
R47L/Y51F/I263R	0%			
R19/F87A/A328F	18%		22%	78%
R19/F87A/I263G	16%	2%	58%	39%

RP/A82W/I263A	4%	32%	54%	14%
RP/A82M/I263A	2%	85%		15%
RP/F87V	15%	1%	51%	48%
RP/V78I/F87V	20%	1%	56%	43%
RP/H171L/A184I/I263G	71%		54%	46%
R19/I263G/A328L	19%		18%	82%
RP/V78I/F87V/H171L/I263G	36%	39%		61%
RP/V78I/E267V	9%		31%	69%
RT2/S72W/A330W	20%	18%	82%	

Appendix 3.14: 6Me-Q (**57**) by the WY3/4 plates.

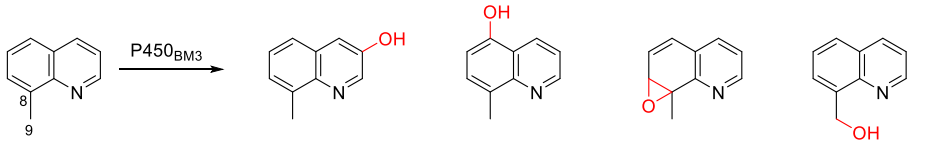


57 | **89** R19/F87A/A328L 91%, TON 1,700 | **90** RT2/S72W/A330W 92%, TON 1,430 | **91** RP/H171L/I263G 100%, TON 1,930

Mutant	conv.	89	90	91
R19/A330W	16%	14%	86%	
K19/F87A/I263G	0%			
GVQ	2%	100%		
R19/F87I	32%	65%	9%	26%
K19/F87V	73%	92%	4%	4%
K19/F87V/E267V	44%	78%	6%	17%
K19/A82M/F87A/I263G	0%			
K19/F87V/A328V	94%	72%		28%
K19/F81W/F87A	12%	100%		
K19/F87A/I263A	0%			
K19/F87V/Q403P	64%	91%	9%	
KU3/A328I/A330P	0%			
R19/A184I/A328L	77%	2%		98%
GVQ/I263G/A328L	61%			100%
R19	33%	27%	73%	
R19/F87A/A184I	16%	100%		
R19/F87A/A328I	16%	100%		
R19/F87A	37%	100%		
GV/A184I	56%	67%	3%	30%
RT2	39%	26%	70%	
RT2/S72G/A330W	0%			
RT2/V78I/A184I/A330P	38%	12%	72%	16%
KU3/A330P	36%	4%	90%	6%
RP/H171L/I263G	97%			100%
RP/I263A/E267V	17%	9%		91%
GVQ/I263A/A328I	0%			
WT	20%	14%	86%	
GVQ/I263G	0%			
GVQ/A264G	17%	95%	5%	
K19/F87V/A264G	35%	93%	7%	
K19/V78I/F87V/E267V	49%	76%	7%	18%
K19/A82M/F87A/E267F	15%	74%	4%	22%
K19/A82M/F87A	13%	36%	25%	39%
R19/F87A/A328L	94%	91%	1%	9%
R19/S72W/F87A/A328I	0%			
R19/V78I/F87A/A328I	0%			
R47L/Y51F/I263R	0%			
R19/F87A/A328F	25%	85%	2%	13%
R19/F87A/I263G	2%	100%		
RP/A82W/I263A	4%		74%	26%
RP/A82M/I263A	57%		37%	63%
RP/F87V	63%	55%	39%	5%
RP/V78I/F87V	14%	23%	57%	8%
RP/H171L/A184I/I263G	89%			100%
R19/I263G/A328L	8%		13%	87%
RP/V78I/F87V/H171L/I263G	25%	8%	21%	70%

RP/V78I/E267V	54%	67%	29%	4%
RT2/S72W/A330W	78%	6%	92%	2%

Appendix 3.15: 8Me-Q (**72**) by the WY1/2 plates.

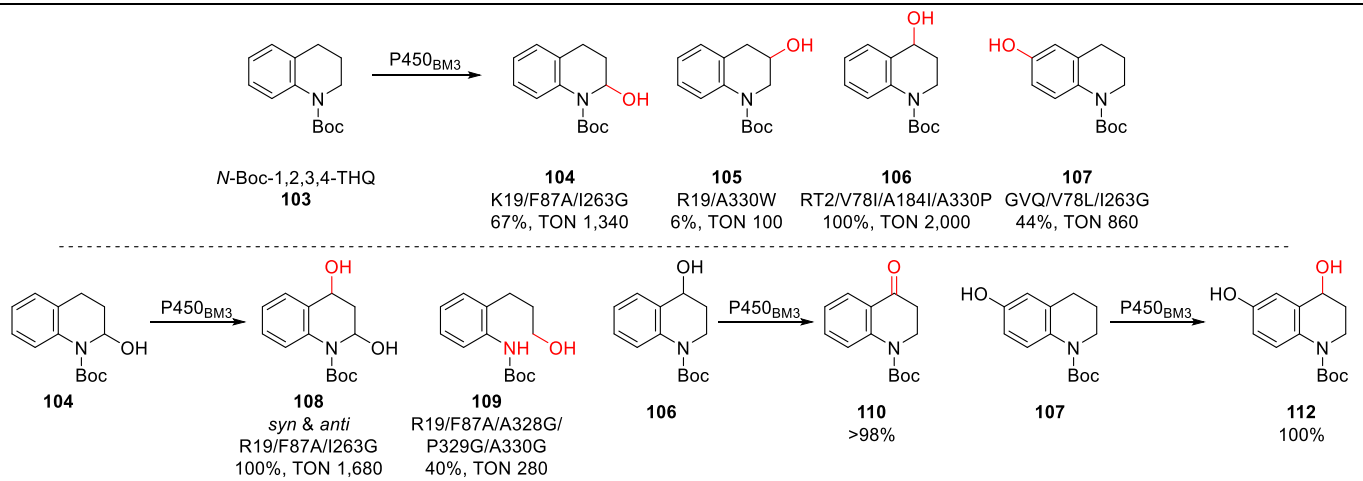


72 | **73** K19/F81W/F87A 2%, TON 30 | **96** KU3/S72W/A330P 100%, TON 860 | **97** RP/H171L/I263G 62%, TON 1,220 | **98** R19/F87A/A328L 94%, TON 1,030

Mutant	Conv.	73	96	97	98
A330P	21%	0%	49%	28%	6%
A82T/I263R	8%	0%	0%	5%	0%
GVQ	9%	0%	13%	0%	66%
K19	48%	0%	79%	10%	2%
K19/F87V	45%	0%	28%	5%	20%
K19/F87V/E267V	19%	0%	0%	60%	0%
K19/A82M/F87A/I263G	28%	0%	0%	57%	43%
K19/F87V/A328I	75%	0%	4%	6%	81%
K19/F81W/F87A	59%	2%	0%	8%	72%
K19/F87A/I263A	8%	0%	0%	43%	35%
K19/F87V/Q403P	23%	0%	51%	17%	27%
KU3/A328I/A330P	12%	0%	21%	17%	0%
KU3/S72W/A330P	43%	0%	100%	0%	0%
KU3/V78I/A330P	34%	0%	28%	12%	6%
R19	41%	0%	63%	11%	0%
R19/F87A/A184I	38%	0%	11%	8%	38%
R19/F87A/A328I	46%	0%	0%	6%	89%
R19/F87A	21%	0%	30%	4%	61%
RP/H171L	66%	0%	87%	6%	7%
RT2	54%	0%	53%	11%	8%
RT2/S72G/A330W	19%	0%	21%	0%	0%
RT2/V78I/A184I/A330P	34%	0%	79%	10%	11%
KU3/A330P	40%	0%	80%	0%	0%
RP/H171L/I263G	98%	0%	26%	62%	11%
A82M/A330P	29%	0%	95%	2%	0%
I263A/A330P	11%	3%	15%	17%	14%
F81W/T260A	8%	0%	24%	25%	6%
GV/A184I	17%	0%	36%	4%	59%
GVQ/A264G	10%	0%	40%	11%	21%
K19/F87V/A264G	13%	0%	55%	13%	11%
K19/V78I/F87V/E267V	16%	0%	7%	1%	59%
K19/A82M/F87A/E267F	51%	0%	53%	10%	30%
R19/F87A/E267F/A328I	61%	0%	3%	4%	92%
R19/F87A/A328L	55%	0%	3%	3%	94%
R19/S72W/F87A/A328I	6%	0%	0%	0%	100%
R19/V78I/F87A/A328I	10%	0%	0%	0%	100%
R47L/Y51F/I263R	46%	0%	52%	40%	9%
R19/F87A/A328F	68%	0%	4%	2%	89%

R19/F87A/I263G	9%	0%	0%	42%	28%
RP/A82W/I263A	12%	0%	0%	52%	0%
RP/A82M/I263A	52%	0%	46%	39%	14%
RP/F87V	36%	0%	35%	3%	40%
RP/V78I/F87V	47%	0%	73%	4%	16%
RP/H171L/A184I/I263G	59%	0%	51%	31%	14%
RT2/H171L/I263G/A330W	54%	0%	33%	51%	6%
RP/V78I/F87V/H171L/I263G	27%	0%	14%	39%	27%
RP/V78I/E267V	31%	0%	40%	0%	55%
RT2/S72W/A330W	46%	0%	75%	8%	5%

Appendix 3.16: *N*-Boc-THQ (**103**) by the WY7/8 plates.

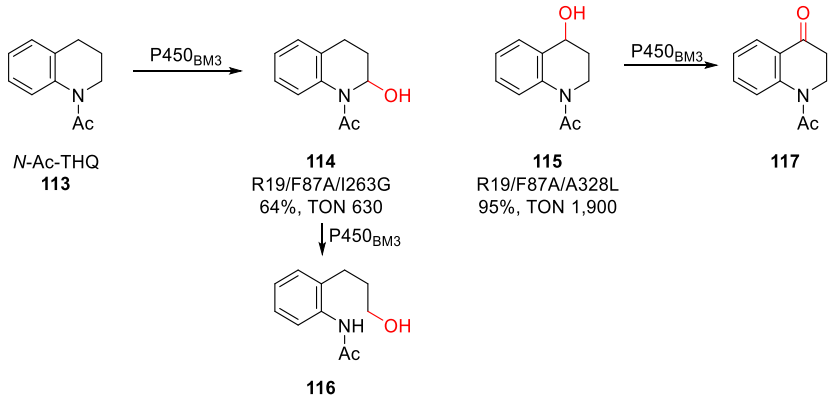


Mutant	conv.	*6 h*	104	105	106	107	*16 h*	104	105	106	107	108	109	110	112
R19/A330W	81%		9%	6%	81%	4%		7%	6%	80%	4%	3%	0%	1%	0%
K19/F87A/I263G	100%		67%	0%	29%	4%		9%	0%	24%	0%	53%	5%	5%	4%
GVQ	99%		4%	1%	95%	0%		1%	1%	81%	0%	2%	0%	14%	0%
R19/F87I	100%		0%	2%	98%	0%		0%	2%	61%	0%	0%	0%	36%	0%
K19/F87V	100%		7%	0%	90%	4%		0%	0%	43%	0%	7%	0%	47%	4%
K19/F87V/E267V	96%		15%	2%	81%	1%		3%	2%	60%	0%	11%	0%	21%	1%
K19/A82M/F87A/I263G	47%		36%	1%	63%	0%		33%	1%	62%	0%	0%	3%	2%	0%
K19/F87V/A328V	96%		1%	1%	98%	0%		1%	1%	91%	0%	0%	0%	7%	0%
K19/F81W/F87A	98%		19%	1%	80%	0%		11%	1%	72%	0%	6%	2%	8%	0%
K19/F87A/I263A	100%		44%	0%	55%	1%		28%	0%	52%	1%	11%	5%	3%	0%
K19/F87V/Q403P	100%		1%	0%	99%	0%		0%	0%	64%	0%	1%	0%	35%	0%
KU3/A328I/A330P	48%		0%	0%	100%	0%		0%	0%	100%	0%	0%	0%	0%	0%
R19/A184I/A328L	72%		0%	0%	96%	4%		0%	0%	96%	4%	0%	0%	0%	0%
R19/F87A/A328G	100%		47%	2%	51%	0%		14%	2%	44%	0%	30%	3%	6%	0%
R19	98%		2%	0%	98%	0%		0%	0%	93%	0%	2%	0%	5%	0%

R19/F87A/A184I	100%	82%	0%	18%	0%	0%	0%	18%	0%	82%	0%	0%	0%
GVQ/V78L/I263G	98%	8%	2%	47%	44%	3%	2%	36%	11%	4%	1%	11%	33%
R19/F87A	100%	47%	0%	53%	0%	0%	0%	34%	0%	46%	1%	19%	0%
GV/A184I	100%	6%	0%	94%	0%	0%	0%	68%	0%	6%	0%	26%	0%
RT2	100%	3%	0%	97%	0%	0%	0%	87%	0%	3%	0%	9%	0%
R19/F87A/I263G/A264G	100%	23%	0%	73%	4%	8%	0%	40%	0%	13%	2%	33%	4%
RT2/V78I/A184I/A330P	100%	0%	0%	100%	0%	0%	0%	99%	0%	0%	0%	1%	0%
R19/F87A/G265GG	78%	11%	1%	89%	0%	8%	1%	80%	0%	2%	1%	9%	0%
RP/H171L/I263G	100%	0%	0%	66%	34%	0%	0%	66%	0%	0%	0%	0%	34%
RP/I263A/E267V	98%	0%	0%	98%	2%	0%	0%	93%	0%	0%	0%	5%	2%
R19/S72W/F87A/A328I	100%	0%	2%	98%	0%	0%	2%	93%	0%	0%	0%	4%	0%
WT	20%	0%	0%	100%	0%	0%	0%	100%	0%	0%	0%	0%	0%
GVQ/I263G	94%	15%	1%	52%	31%	8%	1%	46%	11%	8%	0%	6%	21%
GVQ/A264G	95%	2%	0%	95%	3%	2%	0%	88%	1%	0%	0%	7%	2%
K19/F87V/A264G	100%	2%	0%	95%	3%	1%	0%	71%	0%	1%	0%	24%	3%
K19/V78I/F87V/E267V	95%	16%	2%	82%	0%	4%	2%	68%	0%	12%	0%	14%	0%
K19/A82M/F87A/E267F	96%	4%	0%	96%	0%	1%	0%	70%	0%	4%	0%	26%	0%
K19/A82M/F87A	99%	11%	0%	89%	0%	4%	0%	79%	0%	5%	1%	10%	0%
R19/F87A/A328L	100%	4%	1%	94%	1%	0%	1%	87%	0%	4%	0%	7%	1%
R19/F87A/A264G/A328G	100%	35%	1%	64%	0%	24%	1%	51%	0%	6%	4%	13%	0%
R19/V78I/F87A/A328I	100%	0%	1%	99%	0%	0%	1%	86%	0%	0%	0%	12%	0%
R19/F87I/L437LV	98%	0%	1%	99%	0%	0%	1%	95%	0%	0%	0%	5%	0%
GVQ/A330W	100%	3%	1%	94%	2%	0%	1%	73%	0%	3%	0%	21%	2%
R19/F87A/I263G	100%	85%	0%	15%	0%	0%	0%	11%	0%	84%	2%	4%	0%
GVQ/A82M/I263G	68%	36%	3%	55%	6%	31%	3%	53%	5%	2%	3%	2%	1%
RP/A82M/I263A	59%	6%	3%	87%	4%	3%	3%	85%	4%	3%	0%	2%	0%
RP/F87V	97%	1%	1%	98%	0%	1%	1%	87%	0%	0%	0%	11%	0%
RP/V78I/F87V	65%	0%	1%	98%	1%	0%	1%	97%	1%	0%	0%	1%	0%
I263G	83%	0%	1%	75%	25%	0%	1%	73%	17%	0%	0%	1%	7%

GVQ/I263G/A328L	18%	0%	5%	77%	18%	0%	5%	77%	18%	0%	0%	0%	0%
R19/F87A/A328G/P329G/A330G	99%	51%	5%	44%	0%	16%	5%	35%	0%	21%	14%	9%	0%
RP/V78I/E267V	99%	3%	1%	96%	0%	1%	1%	70%	0%	1%	0%	27%	0%
R19/I263A/A328L	35%	0%	0%	68%	32%	0%	0%	68%	32%	0%	0%	0%	0%

Appendix 3.17: *N*-Ac-THQ (**113**) by the WY7/8 plates.



N-Ac-THQ
113

114
R19/F87A/I263G
64%, TON 630

115
R19/F87A/A328L
95%, TON 1,900

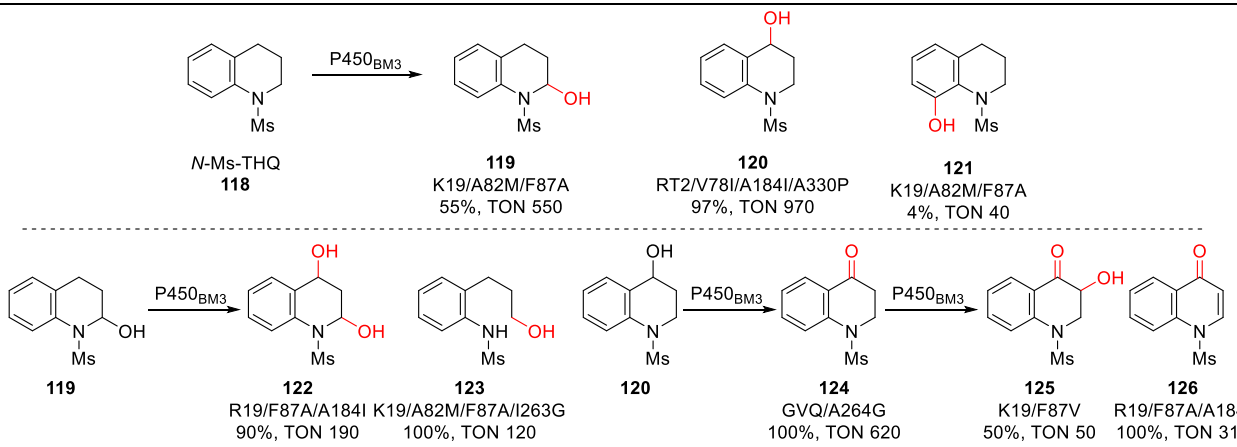
117

116

Mutant	Conversion	selectivity		Further oxidation (Conv.)	
		114	**115**	**116**	**117**
R19/A330W	7%	5%	95%	0%	12%
K19/F87A/I263G	17%	55%	45%	64%	11%
GVQ	89%	8%	92%	90%	21%
R19/F87I	44%	7%	93%	56%	7%
K19/F87V	95%	5%	95%	100%	35%
K19/F87V/E267V	47%	4%	96%	100%	7%
K19/A82M/F87A/I263G	10%	56%	44%	23%	22%
K19/F87V/A328V	82%	7%	93%	92%	7%
K19/F81W/F87A	83%	10%	90%	100%	7%
K19/F87A/I263A	4%	23%	77%	49%	27%
K19/F87V/Q403P	93%	6%	94%	100%	29%
KU3/A328I/A330P	11%	8%	92%	100%	18%
R19/A184I/A328L	18%	7%	93%	100%	6%
R19/F87A/A328G	55%	17%	83%	86%	7%
R19	47%	13%	87%	83%	4%
R19/F87A/A184I	96%	9%	91%	100%	32%
GVQ/V78L/I263G	46%	5%	95%	100%	5%
R19/F87A	100%	13%	87%	100%	11%
GV/A184I	84%	6%	94%	100%	13%
RT2	82%	10%	90%	96%	3%
R19/F87A/I263G/A264G	13%	27%	73%	67%	11%
RT2/V78I/A184I/A330P	85%	9%	91%	100%	3%
R19/F87A/G265GG	15%	12%	88%	71%	9%
RP/H171L/I263G	89%	31%	69%	100%	5%
RP/I263A/E267V	92%	6%	94%	100%	3%
R19/S72W/F87A/A328I	69%	9%	91%	100%	4%
WT	8%	0%	100%		10%
GVQ/I263G	49%	7%	93%	82%	4%
GVQ/A264G	93%	3%	97%	100%	17%
K19/F87V/A264G	90%	4%	96%	100%	15%
K19/V78I/F87V/E267V	40%	6%	94%	53%	7%
K19/A82M/F87A/E267F	68%	14%	86%	86%	10%
K19/A82M/F87A	100%	15%	85%	100%	22%
R19/F87A/A328L	100%	5%	95%	100%	5%
R19/F87A/A264G/A328G	29%	11%	89%	78%	8%
R19/V78I/F87A/A328I	94%	8%	92%	82%	7%
R19/F87I/L437LV	17%	31%	69%	48%	10%
GVQ/A330W	95%	6%	94%	92%	22%

R19/F87A/I263G	49%	64%	36%	55%	0%
GVQ/A82M/I263G	15%	9%	91%	55%	8%
RP/A82M/I263A	26%	26%	74%	73%	6%
RP/F87V	44%	8%	92%	93%	7%
RP/V78I/F87V	16%	0%	100%		6%
I263G	93%	29%	71%	80%	3%
GVQ/I263G/A328L	2%	7%	93%	100%	36%
R19/F87A/A328G/P329G/A330G	36%	24%	76%	92%	9%
RP/V78I/E267V	76%	8%	92%	100%	12%
R19/I263A/A328L	7%	0%	100%		14%
R1/I263G	100%	49%	51%	23%	6%
R1/I263G/L437LV*	100%	68%	32%	2%	9%
R1/I263G/L437VL*	100%	86%	14%	13%	16%

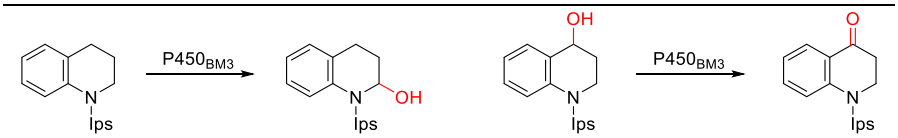
Appendix 3.18: *N*-Ms-THQ (**118**) by the WY7/8 plates.



Mutant	Conv.	*12 h*	119	120	121	*24 h*	119	122	123	*36 h*	120	124	125	126
R19/A330W	21%		0%	100%	0%		0%	0%	0%		100%	0%		0%
K19/F87A/I263G	22%		70%	30%	0%		38%	0%	32%		30%	0%		0%
GVQ	100%		8%	92%	0%		2%	6%	0%		54%	38%		0%
R19/F87I	75%		2%	98%	0%		2%	0%	0%		90%	8%		0%
K19/F87V	100%		11%	89%	1%		0%	11%	0%		30%	49%	5%	5%
K19/F87V/E267V	30%		0%	100%	0%		0%	0%	0%		100%	0%		0%
K19/A82M/F87A/I263G	33%		74%	26%	0%		39%	0%	35%		26%	0%		0%
K19/F87V/A328V	96%		2%	98%	0%		0%	0%	2%		88%	10%		0%
K19/F81W/F87A	93%		21%	77%	0%		5%	3%	12%		72%	5%		0%
K19/F87A/I263A	17%		71%	29%	0%		24%	0%	47%		29%	0%		0%
K19/F87V/Q403P	100%		13%	87%	0%		3%	5%	2%		58%	29%		0%
KU3/A328I/A330P	47%		3%	97%	0%		0%	0%	3%		97%	0%		0%
R19/A184I/A328L	56%		20%	80%	0%		0%	0%	3%		80%	0%		0%
R19/F87A/A328G	89%		38%	59%	0%		16%	3%	20%		56%	3%		0%
R19	71%		0%	100%	0%		0%	0%	0%		100%	0%		0%
R19/F87A/A184I	100%		23%	76%	2%		2%	19%	2%		15%	31%		31%
GVQ/V78L/I263G	90%		2%	98%	0%		0%	1%	1%		96%	2%		0%
R19/F87A	100%		23%	73%	0%		5%	6%	12%		68%	6%		0%
GV/A184I	100%		4%	96%	0%		0%	3%	1%		63%	33%		0%

RT2	68%	0%	100%	0%	0%	0%	0%	100%	0%	0%
R19/F87A/I263G/A264G	51%	43%	57%	0%	23%	2%	18%	55%	2%	0%
RT2/V78I/A184I/A330P	100%	3%	97%	0%	0%	3%	0%	97%	0%	0%
R19/F87A/G265GG	63%	22%	78%	0%	5%	2%	14%	72%	6%	0%
RP/H171L/I263G	100%	17%	82%	1%	0%	13%	4%	76%	4%	2%
RP/I263A/E267V	77%	7%	93%	0%	2%	0%	5%	93%	1%	0%
R19/S72W/F87A/A328I	100%	3%	97%	0%	0%	0%	3%	95%	3%	0%
WT	11%	0%	100%	0%	0%	0%	0%	100%	0%	0%
GVQ/I263G	69%	2%	98%	0%	1%	1%	0%	95%	3%	0%
GVQ/A264G	100%	7%	93%	0%	0%	7%	0%	31%	61%	1%
K19/F87V/A264G	100%	9%	89%	2%	0%	8%	2%	35%	53%	1%
K19/V78I/F87V/E267V	9%	0%	100%	0%	0%	0%	0%	100%	0%	0%
K19/A82M/F87A/E267F	82%	35%	65%	0%	8%	6%	21%	62%	3%	0%
K19/A82M/F87A	100%	55%	41%	4%	10%	17%	27%	36%	5%	0%
R19/F87A/A328L	100%	3%	97%	0%	0%	3%	0%	91%	7%	0%
R19/F87A/A264G/A328G	69%	43%	55%	0%	12%	3%	28%	52%	3%	0%
R19/V78I/F87A/A328I	100%	8%	92%	0%	3%	3%	2%	87%	6%	0%
R19/F87I/L437LV	4%	0%	92%	0%	0%	0%	0%	92%	0%	0%
GVQ/A330W	100%	10%	90%	0%	2%	7%	1%	57%	32%	1%
R19/F87A/I263G	57%	66%	34%	0%	61%	2%	2%	34%	0%	0%
GVQ/A82M/I263G	38%	0%	100%	0%	0%	0%	0%	97%	3%	0%
RP/A82M/I263A	49%	7%	93%	0%	2%	1%	3%	92%	2%	0%
RP/F87V	93%	7%	93%	0%	1%	2%	4%	84%	9%	0%
RP/V78I/F87V	29%	0%	100%	0%	0%	0%	0%	100%	0%	0%
I263G	96%	12%	88%	0%	10%	2%	1%	86%	1%	0%
GVQ/I263G/A328L	2%	0%	100%	0%	0%	0%	0%	100%	0%	0%
R19/F87A/A328G/P329G/A330G	97%	17%	82%	0%	2%	4%	12%	69%	12%	1%
RP/V78I/E267V	97%	20%	79%	1%	3%	5%	12%	65%	14%	0%
R19/I263A/A328L	17%	40%	60%	0%	0%	0%	2%	60%	0%	0%

Appendix 3.19: *N*-Ips-THQ (**127**) by the WY5/6 plates.

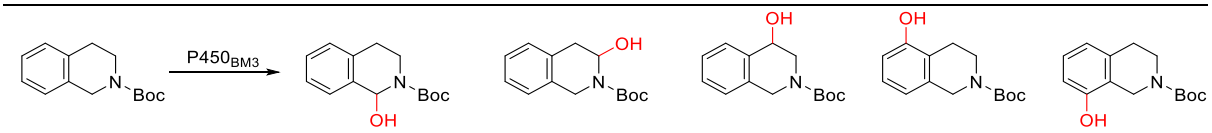


N-Ips-THQ **127** | **128** R19/F87A/A328G 82%, TON 710 | **129** RP/H171L/I263G/L437LV 100%, TON 1,000 | **130**

Mutant	Conv.	128	129
R19/A330W	5%		100%
K19/F87A/I263G	68%	17%	83%
GVQ	100%	15%	85%
R19/F87I	12%		100%
K19/F87V	100%	21%	79%
K19/F87V/E267V	13%		100%
K19/A82M/F87A/I263G	19%	46%	54%
K19/F87V/A328V	80%		100%
K19/F81W/F87A	72%	22%	78%
K19/F87A/I263A	20%	29%	71%
K19/F87V/Q403P	100%	30%	70%
KU3/A328I/A330P	5%		100%
R19/A184I/A328L	15%		100%
R19/F87A/A328G	87%	82%	18%
R19	30%		100%
R19/F87A/A184I	100%	43%	57%
A82F/I263F	23%		100%
R19/F87A	61%	28%	72%
GV/A184I	85%	4%	96%
RT2	70%		100%
RT2/S72G/A330W	0%		
RT2/V78I/A184I/A330P	84%		100%
KU3/A330P	70%		100%
RP/H171L/I263G	33%		100%
RP/I263A/E267V	3%		100%
RP/H171L/I263G/L437LV	100%		100%
WT	2%		100%
GVQ/I263G	0%		
GVQ/A264G	29%	5%	95%
K19/F87V/A264G	31%	4%	96%
K19/V78I/F87V/E267V	3%		100%
K19/A82M/F87A/E267F	3%		100%
K19/A82M/F87A	98%	16%	84%
R19/F87A/A328L	99%	1%	99%
R19/F87A/A264G/A328G	14%	61%	39%
R19/V78I/F87A/A328I	19%		100%
R19/F87I/L437LV	6%		100%
R19/F87A/A328F	100%	15%	85%
R19/F87A/I263G	93%	17%	83%
RP/A82W/I263A	16%		100%
RP/A82M/I263A	7%		100%
RP/F87V	18%	3%	97%
RP/V78I/F87V	2%		100%
I263G	3%		100%
R19/I263G/A328L	2%		100%

RP/V78I/F87V/H171L/I263G	40%	3%	97%
RP/V78I/E267V	98%	12%	88%
RT2/S72W/A330W	0%		

Appendix 3.20: *N*-Boc-THIQ (**131**) by the WY7/8 plates.

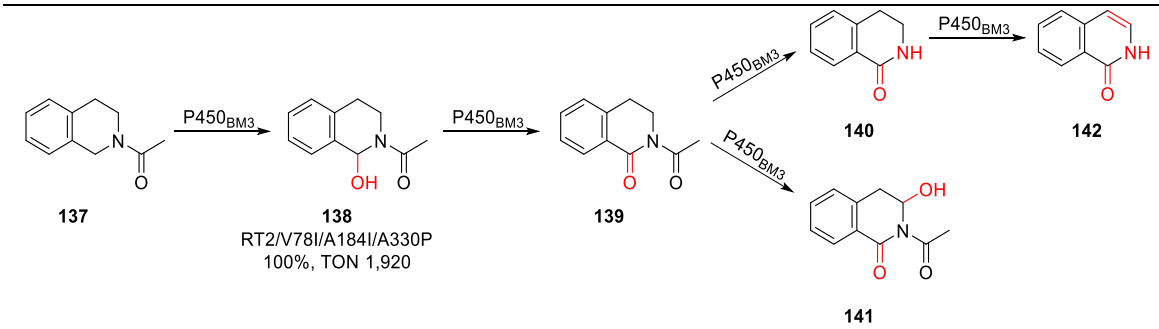


131 | **132** K19/A82M/F87A 63%, TON 1,130 | **133** R19/F87A/A264G/A328G 51%, TON 960 | **134** R19/F87A/A328L 94%, TON 1,800 | **135** R19/A184I/A328L 21%, TON 100 | **136** R19/A184I/A328L 33%, TON 150

Mutant	conversion	132	133	134	135	136
R19/A330W	89%	14%	3%	82%	1%	
K19/F87A/I263G	65%	52%	15%	33%		
GVQ	98%	32%	6%	62%		
R19/F87I	99%	45%	2%	54%		
K19/F87V	100%	25%	4%	71%		
K19/F87V/E267V	99%	22%	7%	71%		
K19/A82M/F87A/I263G	57%	63%	7%	30%		
K19/F87V/A328V	82%	17%	3%	80%		
K19/F81W/F87A	96%	36%	13%	51%		
K19/F87A/I263A	91%	58%	12%	30%		
K19/F87V/Q403P	100%	27%	4%	69%		
KU3/A328I/A330P	18%	30%	3%	63%	2%	1%
R19/A184I/A328L	8%	47%	0%	28%	7%	18%
R19/F87A/A328G	98%	54%	34%	12%		
R19	100%	38%	3%	58%		1%
R19/F87A/A184I	100%	32%	14%	54%		
GVQ/V78L/I263G	100%	30%	21%	49%		
R19/F87A	100%	23%	21%	56%		
GV/A184I	100%	17%	12%	71%		
RT2	100%	33%	2%	65%		
R19/F87A/I263G/A264G	93%	32%	24%	43%		
RT2/V78I/A184I/A330P	66%	7%	3%	85%	3%	2%
R19/F87A/G265GG	46%	36%	27%	37%		
RP/H171L/I263G	81%	15%	5%	76%	2%	1%
RP/I263A/E267V	97%	16%	15%	69%		
R19/S72W/F87A/A328I	84%	3%	2%	95%		
WT	62%	27%	1%	71%	1%	
GVQ/I263G	98%	29%	28%	43%		
GVQ/A264G	79%	47%	5%	47%		
K19/F87V/A264G	93%	30%	4%	65%		
K19/V78I/F87V/E267V	97%	29%	7%	64%		
K19/A82M/F87A/E267F	88%	63%	1%	35%		
K19/A82M/F87A	90%	63%	1%	36%		
R19/F87A/A328L	96%	2%	4%	94%		
R19/F87A/A264G/A328G	94%	35%	51%	14%		
R19/V78I/F87A/A328I	71%	4%	11%	85%		
R19/F87I/L437LV	43%	18%	7%	73%	2%	1%
GVQ/A330W	99%	37%	10%	53%		
R19/F87A/I263G	100%	48%	21%	31%		
GVQ/A82M/I263G	53%	37%	39%	24%		
RP/A82M/I263A	78%	27%	10%	64%		
RP/F87V	40%	26%	8%	66%		
RP/V78I/F87V	61%	22%	1%	77%		
I263G	97%	16%	3%	81%		
GVQ/I263G/A328L	20%	17%	6%	78%		
R19/F87A/A328G/P329G/A330G	87%	58%	28%	14%		

RP/V78I/E267V	98%	34%	7%	59%		
R19/I263A/A328L	23%	21%	3%	22%	21%	33%
R1/I263G	100%	22%	4%	73%		
R1/I263G/L437LV	78%		2%	68%	20%	10%
R1/I263G/L437VL	87%	3%	3%	65%	15%	14%
R1/I263G/L437LM	57%	19%	2%	60%	10%	9%
R1/I263G/L437LF	76%	5%	3%	68%	12%	12%
R1/I263G/L437LS	73%	4%	5%	75%	7%	10%
R1/I263G/L437LH	44%	6%	2%	55%	17%	20%

Appendix 3.21: *N*-Ac-THIQ (**137**) by the WY5/6 plates.

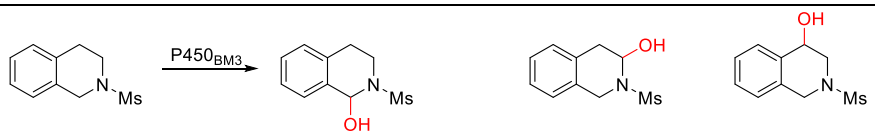


137 **138** RT2/V78I/A184I/A330P 100%, TON 1,920 **139** **140** **142** **141**

Mutant	conversion	138	139	140	141	142
R19/A330W	45%	12%	56%	13%	7%	9%
K19/F87A/I263G	35%	11%	71%	14%	0%	0%
GVQ	60%	25%	18%	11%	40%	3%
R19/F87I	36%	16%	59%	15%	5%	0%
K19/F87V	70%	25%	20%	19%	23%	2%
K19/F87V/E267V	45%	28%	23%	11%	34%	0%
K19/A82M/F87A/I263G	40%	13%	57%	15%	11%	0%
K19/F87V/A328V	31%	24%	53%	15%	4%	0%
K19/F81W/F87A	84%	15%	19%	5%	32%	22%
K19/F87A/I263A	35%	10%	72%	14%	0%	0%
K19/F87V/Q403P	51%	29%	18%	12%	34%	3%
KU3/A328I/A330P	34%	13%	68%	14%	0%	0%
R19/A184I/A328L	37%	9%	73%	14%	0%	0%
R19/F87A/A328G	47%	23%	34%	12%	17%	10%
R19	54%	21%	30%	9%	23%	13%
R19/F87A/A184I	69%	25%	17%	9%	26%	22%
A82F/I263F	37%	17%	46%	14%	19%	0%
R19/F87A	46%	14%	48%	10%	9%	16%
GV/A184I	72%	18%	9%	6%	63%	5%
RT2	66%	28%	8%	7%	38%	15%
RT2/S72G/A330W	34%	12%	69%	14%	0%	0%
RT2/V78I/A184I/A330P	96%	22%	0%	5%	70%	4%
KU3/A330P	34%	10%	72%	14%	0%	0%
RP/H171L/I263G	84%	29%	0%	3%	49%	19%
RP/I263A/E267V	83%	23%	0%	3%	69%	3%
RP/H171L/I263G/L437LV	38%	13%	59%	13%	8%	5%
WT	38%	14%	64%	14%	4%	0%
GVQ/I263G	36%	22%	47%	13%	15%	0%
GVQ/A264G	36%	32%	30%	14%	19%	0%
K19/F87V/A264G	42%	29%	21%	13%	33%	0%
K19/V78I/F87V/E267V	45%	32%	19%	16%	30%	0%
K19/A82M/F87A/E267F	44%	29%	14%	6%	37%	9%
K19/A82M/F87A	42%	17%	46%	10%	14%	10%
R19/F87A/A328L	33%	22%	57%	13%	7%	0%
R19/F87A/A264G/A328G	39%	33%	25%	13%	20%	5%
R19/V78I/F87A/A328I	35%	17%	65%	14%	0%	0%
R19/F87I/L437LV	36%	10%	71%	15%	0%	0%
R19/F87A/A328F	72%	18%	29%	9%	29%	11%
R19/F87A/I263G	35%	16%	58%	15%	7%	0%
RP/A82W/I263A	37%	12%	65%	14%	3%	0%
RP/A82M/I263A	46%	12%	50%	10%	22%	2%
RP/F87V	37%	13%	65%	14%	4%	0%

RP/V78I/F87V	49%	37%	7%	12%	37%	3%
I263G	69%	28%	7%	18%	13%	3%
R19/I263G/A328L	36%	11%	70%	14%	0%	0%
RP/V78I/F87V/H171L/I263G	36%	10%	69%	14%	3%	0%
RP/V78I/E267V	52%	20%	23%	8%	40%	5%
RT2/S72W/A330W	36%	10%	71%	14%	0%	0%

Appendix 3.22: *N*-Ms-THIQ (**143**) by the WY7/8 plates.

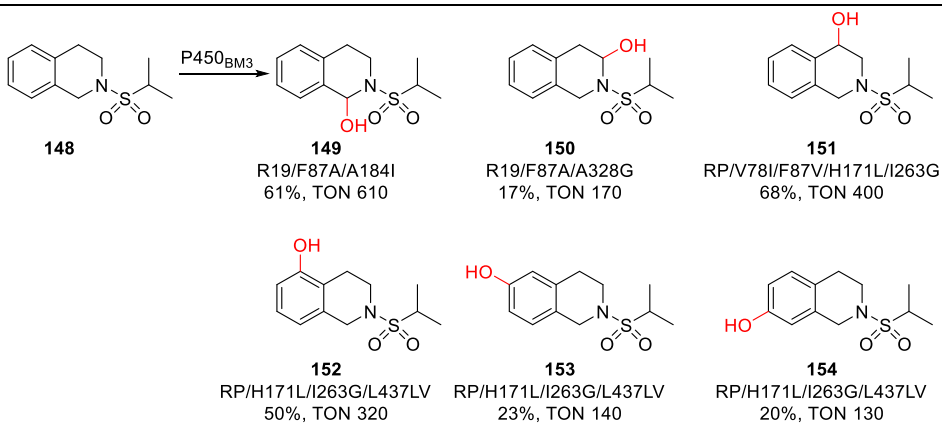


143 | **144** RT2/V78I/A184I/A330P 93%, TON 930 | **145** RP/H171L/I263G 44%, TON 440 | **146** GVQ/V78L/I263G 51%, TON 400

Mutant	conversion	144	145	146
R19/A330W	0%			
K19/F87A/I263G	27%	64%	16%	16%
GVQ	36%	66%	2%	28%
R19/F87I	0%			
K19/F87V	48%	63%	3%	32%
K19/F87V/E267V	15%	60%	6%	27%
K19/A82M/F87A/I263G	0%			
K19/F87V/A328V	0%			
K19/F81W/F87A	19%	50%	14%	33%
K19/F87A/I263A	6%	69%	3%	16%
K19/F87V/Q403P	94%	64%	2%	33%
KU3/A328I/A330P	0%			
R19/A184I/A328L	0%			
R19/F87A/A328G	51%	86%	5%	8%
R19	0%			
R19/F87A/A184I	70%	48%	10%	39%
GVQ/V78L/I263G	78%	31%	13%	51%
R19/F87A	25%	51%	14%	32%
GV/A184I	34%	57%	2%	36%
RT2	74%	82%	2%	14%
R19/F87A/I263G/A264G	15%	57%	23%	14%
RT2/V78I/A184I/A330P	100%	93%	2%	1%
R19/F87A/G265GG	6%	41%	9%	39%
RP/H171L/I263G	100%	31%	44%	16%
RP/I263A/E267V	39%	56%	20%	20%
R19/S72W/F87A/A328I	0%			
WT	0%			
GVQ/I263G	68%	33%	21%	44%
GVQ/A264G	10%	72%	3%	16%
K19/F87V/A264G	11%	68%	7%	18%
K19/V78I/F87V/E267V	6%	61%	4%	25%
K19/A82M/F87A/E267F	19%	47%	4%	45%
K19/A82M/F87A	30%	56%	4%	38%
R19/F87A/A328L	19%	83%	4%	11%
R19/F87A/A328G/A264G	17%	70%	12%	13%
R19/V78I/F87A/A328I	0%			
R19/F87I/L437LV	0%			
GVQ/A330W	37%	68%	6%	23%
R19/F87A/I263G	37%	66%	12%	12%
GVQ/A82M/I263G	9%	36%	9%	47%
RP/A82M/I263A	0%			
RP/F87V	46%	57%	1%	40%
RP/V78I/F87V	23%	74%	5%	16%
I263G	26%	25%	44%	14%
GVQ/I263G/A328L	0%			

R19/F87A/A328G/P329G/A330G	5%	83%	0%	0%
RP/V78I/E267V	49%	52%	2%	42%
R19/I263A/A328L	0%			

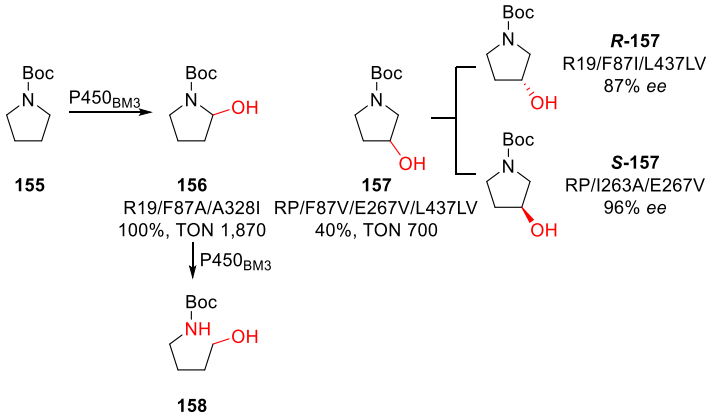
Appendix 3.23: *N*-Ips-THIQ (**148**) by the WY5/6 plates.



Mutant	Conversion	149	150	151	152	153 & 154
R19/A330W	0%	0%	0%	0%	0%	0%
K19/F87A/I263G	53%	37%	13%	42%	0%	0%
GVQ	100%	58%	6%	31%	0%	0%
R19/F87I	8%	32%	6%	40%	0%	0%
K19/F87V	72%	32%	11%	48%	0%	0%
K19/F87V/E267V	24%	42%	6%	41%	0%	0%
K19/A82M/F87A/I263G	20%	0%	8%	78%	0%	0%
K19/F87V/A328V	8%	0%	18%	62%	0%	0%
K19/F81W/F87A	81%	51%	16%	26%	0%	0%
K19/F87A/I263A	49%	37%	10%	42%	0%	0%
K19/F87V/Q403P	48%	53%	24%	17%	0%	0%
KU3/A328I/A330P	0%	0%	0%	0%	0%	0%
R19/A184I/A328L	0%	0%	0%	0%	0%	0%
R19/F87A/A328G	100%	51%	17%	28%	0%	0%
R19	0%	0%	0%	0%	0%	0%
R19/F87A/A184I	100%	61%	13%	21%	0%	0%
A82F/I263F	9%	28%	17%	35%	0%	0%
R19/F87A	26%	48%	19%	18%	0%	0%
GV/A184I	68%	46%	10%	33%	0%	0%
RT2	36%	59%	10%	18%	0%	0%
RT2/S72G/A330W	3%	0%	0%	42%	0%	0%
RT2/V78I/A184I/A330P	27%	29%	10%	46%	0%	0%
KU3/A330P	15%	0%	8%	51%	0%	0%
RP/H171L/I263G	12%	0%	0%	28%	36%	21%
RP/I263A/E267V	6%	16%	3%	60%	0%	0%
RP/H171L/I263G/L437LV	63%	0%	1%	4%	50%	43%
WT	0%	0%	0%	0%	0%	0%
GVQ/I263G	2%	0%	0%	50%	0%	0%
GVQ/A264G	57%	56%	3%	29%	2%	1%
K19/F87V/A264G	100%	49%	3%	32%	0%	0%
K19/V78I/F87V/E267V	23%	48%	3%	37%	0%	0%
K19/A82M/F87A/E267F	75%	36%	10%	44%	0%	0%
K19/A82M/F87A	76%	33%	7%	46%	0%	0%

R19/F87A/A328L	30%	18%	5%	70%	0%	0%
R19/F87A/A264G/A328G	51%	41%	24%	26%	0%	0%
R19/V78I/F87A/A328I	30%	48%	17%	21%	0%	0%
R19/F87I/L437LV	6%	15%	0%	36%	0%	0%
R19/F87A/A328F	26%	12%	32%	45%	0%	0%
R19/F87A/I263G	100%	40%	12%	33%	0%	0%
RP/A82W/I263A	12%	26%	5%	35%	0%	0%
RP/A82M/I263A	11%	32%	2%	46%	0%	0%
RP/F87V	83%	55%	5%	33%	1%	1%
RP/V78I/F87V	21%	43%	9%	26%	0%	0%
I263G	19%	17%	4%	31%	24%	18%
R19/I263G/A328L	10%	0%	0%	17%	18%	45%
RP/V78I/F87V/H171L/I263G	58%	19%	5%	68%	0%	0%
RP/V78I/E267V	90%	49%	5%	35%	2%	2%
RT2/S72W/A330W	16%	47%	10%	18%	0%	0%

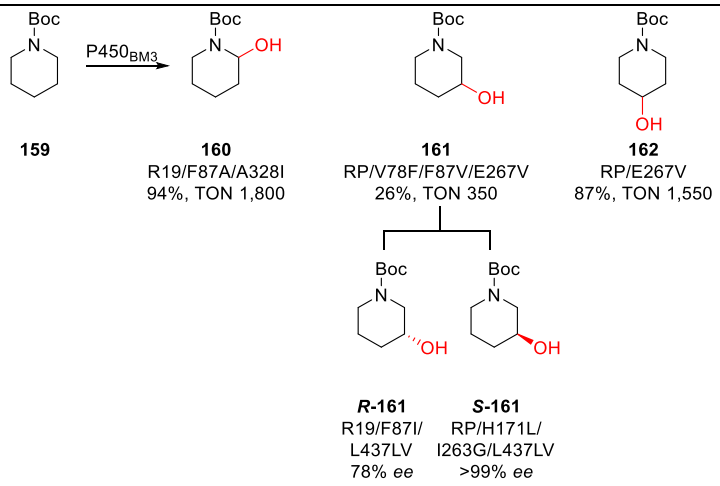
Appendix 3.24: *N*-Boc-pyrrolidine (**155**) by the TFA1/B plates and 2nd generatation variants.



Mutant	Conversion	156	157	*enantiomeric excess*	158
R19/F87A/A328I	94%	17%	-		83%
K19/A82M/F87A	94%	22%	-		75%
K19/Y51L/F87A/A328I	51%	39%	-		61%
K19/F87A/A184I/A328I	95%	18%	1%		80%
GVQ/I263G	83%	4%	7%	34% *ee* to *S*	84%
K19/F87A/I263A	34%	48%	-		52%
RP	97%	18%	-		80%
RP/E263V	94%	19%	3%	44% *ee* to *S*	77%
RT2/F81W	94%	18%	1%		80%
RP/F87V/E267V	96%	28%	16%	66% *ee* to *R*	33%
K19/F87V/A328I	90%	16%	-		84%
RP/F87V/E267V/L437LV	87%	15%	40%	76% *ee* to *R*	36%
K19/V78I/F87A/A328I	43%	24%	-		76%
RT2/A330P/I401M	96%	19%	-		81%
RT2/A330P/A82M	90%	1%	2%		97%
RT2/I401P	91%	14%	-		84%
RT2/A330P	94%	23%	-		77%
RT2/A184I/A330P	99%	2%	-		95%
RT2/V78I/A330P	69%	47%	-		50%
RT2	83%	30%	-		69%
RP/I263A/E267V	95%	10%	12%	96% *ee* to *S*	65%
WT	0%	-	-		-
RP/A330P	89%	18%	-		74%
RP/F87V	99%	14%	4%	30% *ee* to *R*	71%
A330P	10%	38%	-		61%
RP/F81W	82%	2%	-		98%
RT2/S72A/A184I/A330P	58%	27%	-		71%
RP/H171L/I263G	99%	5%	18%	89% *ee* to S	62%
R19/F87I	89%	33%	7%	75% *ee* to *R*	58%
GVQ	50%	27%	1%		70%
RT2/A330W	44%	28%	-		70%
F87A	44%	34%	-		63%
R19/F87A	89%	24%	1%		62%

RP/A82M/I263A	70%	5%	4%	62% *ee* to *S*	90%
R19/F87A/A328L	58%	32%	2%		65%
R47L/Y51F	42%	20%	-		79%
K19/A82M/F87A/E267F	85%	40%	1%		56%
RP/H171L	96%	28%	-		65%
RP/E267G	1%	100%	-		-
KSK48	3%	55%	-		45%
K19/F87V/Q403P	89%	29%	3%	58% *ee* to *R*	66%
RT2/V78I/A184I/A330P	96%	3%	-		96%
RP/F87V/L188Q/E267V	98%	12%	1%		67%
RP/V78F/F87V/E267V	71%	6%	20%	61% *ee* to *R*	73%
RT2/F81W/A328I	83%	45%	2%	31% *ee* to *R*	50%
RP/E267M	74%	39%	1%		58%
K19/F87A/I263A/A328I	25%	33%	1%		66%
RT2/S72W/A330W	87%	20%	-		79%
2nd generation mutants					
R19/F87I/L437LV	100%	9%	7%	87% *ee* to *R*	82%
R19/F87A/A328F	60%	22%	13%	86% ee to *R*	64%
RP/I263G/E267V	100%	2%	5%	98% *ee* to *S*	72%
RP/H171L/I263G/E267V	100%	3%	6%	98% *ee* to *S*	55%

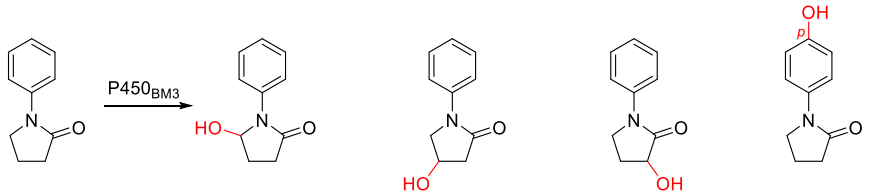
Appendix 3.25: *N*-Boc-piperidine (**159**) by the TFA1/B plates and 2nd generatation variants.



Mutant	Conv.	160	161	*enantiomeric excess*	162
R19/F87A/A328I	96%	77%	0%		6%
K19/A82M/F87A	97%	66%	1%		24%
K19/Y51L/F87A/A328I	80%	92%	0%		6%
K19/F87A/A184I/A328I	93%	76%	0%		8%
GVQ/I263G	89%	69%	2%		19%
K19/F87A/I263A	95%	74%	1%		17%
RP	94%	83%	1%		5%
RP/E263V	89%	9%	4%		87%
RT2/F81W	91%	83%	0%		10%
RP/F87V/E267V	94%	13%	7%	56% *ee* to *S*	77%
K19/F87V/A328I	86%	89%	1%		1%
RP/F87V/E267V/L437LV	78%	4%	13%	24% *ee* to *S*	82%
K19/V78I/F87A/A328I	67%	94%	0%		4%
RT2/A330P/I401M	91%	39%	1%		57%
RT2/A82M/A330P	87%	38%	2%	32% *ee* to *R*	60%
RT2/I401P	89%	84%	1%		6%
RT2/A330P	88%	44%	1%		50%
RT2/A184I/A330P	94%	27%	1%	2% *ee* to *R*	68%
RT2/V78I/A330P	55%	78%	0%		22%
RT2	94%	84%	1%		5%
RP/I263A/E267V	91%	26%	1%		66%
WT	14%	100%	0%		0%
RP/A330P	79%	66%	0%		30%
RP/F87V	94%	51%	2%		40%
A330P	24%	60%	0%		35%
RP/F81W	70%	85%	0%		9%
RT2/S72A/A184I/A330P	69%	49%	0%		50%
RP/H171L/I263G	75%	18%	2%		75%
R19/F87I	89%	25%	8%	16% *ee* to *R*	65%
GVQ	93%	79%	1%		9%
RT2/A330W	76%	86%	1%		5%
F87A	86%	78%	1%		9%

R19/F87A	87%	63%	1%		17%
RP/A82M/I263A	80%	32%	0%		64%
R19/F87A/A328L	45%	59%	0%		41%
R47L/Y51F	88%	91%	0%		3%
K19/A82M/F87A/E267F	71%	18%	3%		65%
RP/H171L	88%	83%	1%		6%
RP/E267G	12%	75%	0%		11%
KSK48	11%	76%	0%		12%
K19/F87V/Q403P	89%	71%	1%	44% *ee* to *S*	17%
RT2/V78I/A184I/A330P	86%	65%	1%	40% *ee* to *S*	30%
RP/F87V/L188Q/E267V	97%	43%	1%		31%
RP/V78F/F87V/E267V	68%	8%	18%	50% *ee* to *S*	42%
RT2/F81W/A328I	62%	59%	2%	52% *ee* to *R*	23%
RP/E267M	53%	68%	1%		23%
K19/F87A/I263A/A328I	56%	76%	2%		20%
RT2/S72W/A330W	85%	77%	0%		16%
2nd generation mutant					
GVQ/N70S	64%	75%	4%	60% *ee* to *S*	11%
R19/F87A/A328F	68%	0%	1%	40% *ee* to *R*	99%
R19/F87I/L437LV	100%	22%	19%	78% *ee* to *R*	58%
RP/V78F/F87V/E267V/L437LV	97%	0%	27%	28% *ee* to *S*	73%
RP/H171L/I263G/L437LV	97%	0%	6%	>99% *ee* to *S*	94%

Appendix 3.26: *N*-phenyl-γ-butyrolactam (**166**) by the WY1/2 plates and the I263G sub-library.

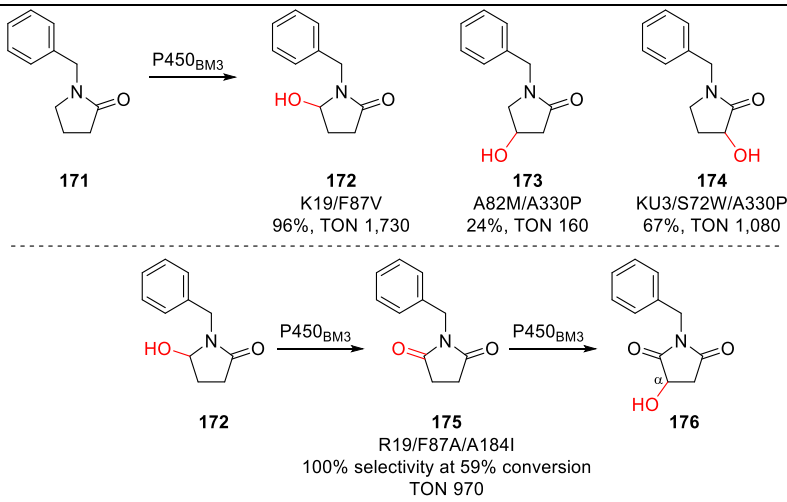


166 | **167** RPH/H171L 94%, TON 1,880 | **168** RP/H171L/I263G 11%, TON 220 | **169** K19/F87V/Q403P 8%, TON 130 | **170** RP/H171L/I263G 16%, TON 330

Mutant	conversion	167	168	169	170
A330P	21%	0%	2%	98%	0%
A82T/I263R	0%				
GVQ	0%				
K19	56%	94%	0%	6%	0%
K19/F87V	82%	94%	0%	6%	0%
K19/F87V/E267V	57%	93%	0%	7%	0%
K19/A82M/F87A/I263G	19%	94%	3%	3%	0%
K19/F87V/A328I	3%	0%	33%	67%	0%
K19/F81W/F87A	63%	94%	0%	6%	0%
K19/F87A/I263A	0%				
K19/F87V/Q403P	81%	92%	0%	8%	0%
KU3/A328I/A330P	0%				
KU3/S72W/A330P	94%	97%	3%	0%	0%
KU3/V78I/A330P	41%	94%	2%	4%	0%
R19	81%	93%	0%	7%	0%
R19/F87A/A184I	67%	94%	0%	6%	0%
R19/F87A/A328I	36%	95%	0%	5%	0%
R19/F87A	63%	94%	0%	6%	0%
RP/H171L	100%	94%	0%	6%	0%
RT2	89%	94%	0%	6%	0%
RT2/S72G/A330W	0%				
RT2/V78I/A184I/A330P	100%	95%	3%	1%	0%
KU3/A330P	60%	93%	2%	5%	0%
RP/H171L/I263G	100%	70%	11%	2%	16%
A82M/A330P	40%	81%	16%	1%	2%
I263A/A330P	0%				
F81W/T260A	19%	95%	0%	5%	0%
GV/A184I	80%	94%	0%	6%	0%
GVQ/A264G	41%	93%	0%	7%	0%
K19/F87V/A264G	36%	94%	0%	6%	0%
K19/V78I/F87V/E267V	17%	95%	0%	5%	0%
K19/A82M/F87A/E267F	75%	94%	0%	6%	0%
R19/F87A/E267F/A328I	2%	0%	77%	23%	0%
R19/F87A/A328L	2%	0%	59%	41%	0%
R19/S72W/F87A/A328I	15%	98%	0%	2%	0%
R19/V78I/F87A/A328I	23%	95%	1%	3%	0%
R47L/Y51F/I263R	65%	76%	10%	2%	12%
R19/F87A/A328F	39%	94%	1%	4%	1%
R19/F87A/I263G	54%	94%	1%	4%	1%
RP/A82W/I263A	1%	0%	0%	100%	0%
RP/A82M/I263A	73%	89%	1%	5%	5%
RP/F87V	78%	93%	0%	7%	0%
RP/V78I/F87V	25%	96%	0%	4%	0%

RP/H171L/A184I/I263G	70%	73%	9%	3%	16%
RT2/H171L/I263G/A330W	100%	83%	1%	2%	14%
RP/V78I/F87V/H171L/I263G	64%	92%	1%	5%	3%
RP/V78I/E267V	78%	93%	0%	7%	0%
RT2/S72W/A330W	81%	93%	0%	7%	0%
I263G sub-library	**conversion**	**167**	**168**	**169**	**170**
I263G	70%	64%	8%	19%	9%
H171L/I263G	58%	53%	10%	21%	16%
R1/I263G	94%	67%	12%	21%	0%
RP/H171L/I263G	92%	65%	12%	23%	0%
RP/A82M/I263G	63%	59%	17%	12%	12%
RP/A82W/I263G	9%	100%	0%	0%	0%
R1/A82M/I263G	36%	61%	17%	11%	11%
R1/F81W/I263G	90%	66%	5%	12%	17%
RP/H171L/I263G/L437LV	99%	33%	0%	56%	11%
R1/I263G/L437LV	97%	27%	0%	61%	11%
R1/I263G/L437VL	100%	51%	2%	48%	0%
R1/I263G/L437LM	57%	71%	0%	18%	11%
R1/I263G/L437LA	24%	44%	0%	34%	22%
R1/I263G/L437LH	10%	56%	0%	18%	0%
R1/I263G/L437LS	5%	74%	0%	26%	0%
R1/I263G/L437S	6%	63%	0%	20%	0%
R1/V78I/I263G/L437LV	86%	36%	0%	52%	12%
R1/V78I/I263G/L437VL	95%	57%	0%	26%	17%
R1/V78I/I263G/L437LM	27%	68%	0%	14%	18%
R1/V78I/I263G/L437LA	26%	32%	0%	44%	25%
R1/V78I/I263G/L437LH	9%	43%	0%	23%	34%
R1/V78I/I263G/L437LS	12%	37%	0%	22%	40%
R1/V78I/I263G/L437LI	78%	44%	0%	56%	0%

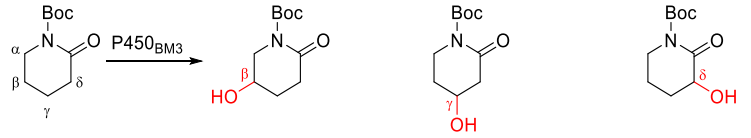
Appendix 3.27: *N*-benzyl-γ-butyrolactam (**171**) by the WY1/2 plates.



Mutant	Conversion	172	173	174	175
A330P	7%	69%	6%	25%	
A82T/I263R	0%				
GVQ	2%	100%			
K19	28%	100%			
K19/F87V	90%	96%			4%
K19/F87V/E267V	5%	100%			
K19/A82M/F87A/I263G	14%	100%			
K19/F87V/A328I	74%	100%			
K19/F81W/F87A	61%	70%			30%
K19/F87A/I263A	1%	69%		31%	
K19/F87V/Q403P	81%	97%			3%
KU3/A328I/A330P	5%	28%	7%	66%	
KU3/S72W/A330P	80%	25%	8%	67%	
KU3/V78I/A330P	28%	78%		22%	
R19	44%	100%			
R19/F87A/A184I	83%	41%			59%
R19/F87A/A328I	29%	100%			
R19/F87A	25%	73%			27%
RP/H171L	81%	97%			3%
RT2	67%	99%	1%		
RT2/S72G/A330W	1%	67%		33%	
RT2/V78I/A184I/A330P	85%	41%	3%	56%	
KU3/A330P	48%	68%	4%	27%	
RP/H171L/I263G	78%	93%	4%		4%
A82M/A330P	32%	28%	24%	47%	
I263A/A330P	2%	84%	16%		
F81W/T260A	21%	100%			
GV/A184I	81%	94%			6%
GVQ/A264G	76%	97%			3%
K19/F87V/A264G	68%	98%			2%
K19/V78I/F87V/E267V	3%	100%			
K19/A82M/F87A/E267F	20%	100%			
R19/F87A/E267F/A328I	42%	99%	1%		
R19/F87A/A328L	39%	98%	2%		
R19/S72W/F87A/A328I	9%	97%	3%		
R19/V78I/F87A/A328I	16%	99%	1%		
R47L/Y51F/I263R	20%	96%	4%		

R19/F87A/A328F	47%	91%			9%
R19/F87A/I263G	30%	75%	1%		25%
RP/A82W/I263A	3%	100%			
RP/A82M/I263A	42%	100%			
RP/F87V	78%	98%			2%
RP/V78I/F87V	16%	97%	3%		
RP/H171L/A184I/I263G	69%	91%	6%	1%	2%
RT2/H171L/I263G/A330W	13%	100%			
RP/V78I/F87V/H171L/I263G	75%	91%			9%
RP/V78I/E267V	75%	98%			2%
RT2/S72W/A330W	51%	96%	4%		

Appendix 3.28: *N*-Boc-δ-velarolactam (**177**) by the WY2/9 plates and I263G sub-library.

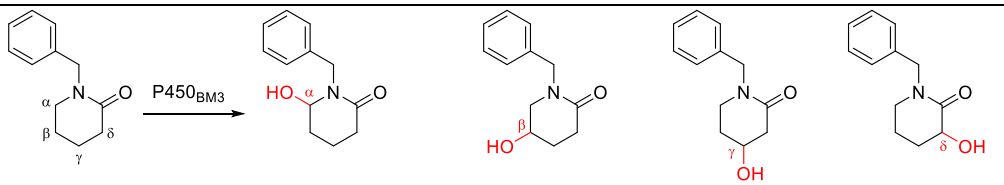


177 | **178** R19/F87A/I263G 3%, TON 40 | **179** R1/V78I/I263G/L437VL 48%, TON 670 | **180** RP/H171L/A184I/I263G 86%, TON 1,530

Mutant	conversion	178	179	180
A82M/A330P	0%			
I263A/A330P	0%			
F81W/T260A	0%			
GV/A184I	2%		30%	70%
GVQ/A264G	1%			100%
K19/F87V/A264G	1%			100%
K19/A82M/F87A/E267F	1%			100%
R19/F87A/E267F/A328I	0%			
R19/F87A/A328L	1%			100%
R19/S72W/F87A/A328I	1%			100%
R19/V78I/F87A/A328I	0%			100%
R47L/Y51F/I263R	4%			100%
R19/F87A/A328F	9%			100%
R19/F87A/I263G	73%	3%	17%	80%
RP/A82W/I263A	0%			
RP/A82M/I263A	0%			
RP/F87V	0%			
RP/V78I/F87V	0%			
RP/H171L/A184I/I263G	89%		14%	86%
RT2/H171L/I263G/A330W	24%		7%	93%
RP/V78I/F87V/H171L/I263G	41%		9%	91%
RP/V78I/E267V	0%			
RT2/S72W/A330W	0%			
R19/A330W	0%			
K19/F87V/I263G	16%		10%	90%
GVQ	0%			
R19/F87I	7%		100%	
K19/F87V	5%		62%	38%
R19/F87A/A328G/P329G/A330G	2%			100%
K19/A82M/F87A/I263G	0%			
K19/F87V/A328V	3%			100%
K19/F81W/F87A	3%			100%
K19/F87A/I263A	0%			
K19/F87V/Q403P	2%		61%	39%
KU3/A328I/A330P	0%			
RP/V78I/E267V	0%			
R19/F87A/A328G	0%			
R19/I263A/A328L	0%			
R19/F87A/A184I	5%			100%
GVQ/V78L/I263G	4%			100%
R19/F87A	15%			100%
GV/A184I	3%		48%	52%
RT2	0%			
R19/F87A/I263G/A264G	14%			100%
K19/A82M/F87A/A330W	5%			100%

R19/F87A/G265GG	0%			
GVQ/I263G/A328L	0%			
I263G sub-library (active variant only)	**conversion**	**178**	**179**	**180**
R19/I263G/A264G/A328G	9%			100%
R19/I263G	40%		10%	89%
R19/I263G/A328G	23%		4%	96%
R1/F81W/I263G	31%		9%	91%
RP/H171L/I263G/L437LV	81%		18%	81%
R1/I263G/L437LV	79%		16%	84%
R1/I263G/L437VL	37%		33%	67%
R1/V78I/I263G/L437LV	61%		18%	82%
R1/V78I/I263G/L437VL	70%		48%	52%

Appendix 3.29: *N*-benzyl-δ-velarolactam (**181**) by the TFA/B, WY1/2 plates and I263G sub-library.



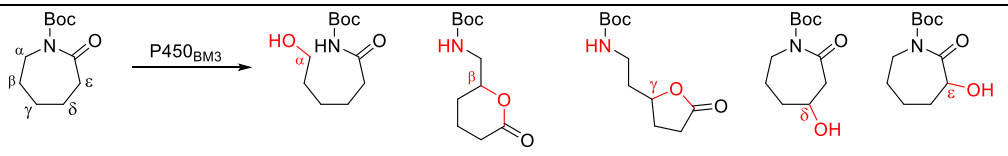
181 | **182** R19/F87A 100%, TON 2,000 | **183** RP/H171L/I263G 7%, TON 140 | **184** KU3/S72W/A330P 43%, TON 710 | **185** RT2/A184I/A330P 56%, TON 1,130

Mutant (TFA/B)	Conversion	182	183	184	185
R19/F87A/A328I	30%	89%	0%	0%	11%
K19/A82M/F87A	82%	99%	0%	1%	0%
K19/Y51L/F87A/A328I	11%	100%	0%	0%	0%
K19/F87A/A184I/A328I	86%	59%	0%	8%	33%
RP/F87V/E267V/L437VL	79%	100%	0%	0%	0%
K19/F87A/I263A	2%	100%	0%	0%	0%
RP	100%	93%	3%	3%	0%
RP/E267V	100%	93%	3%	2%	3%
RT2/F81W	100%	100%	0%	0%	0%
RP/F87V/E267V	95%	96%	1%	3%	0%
K19/F87V/A328I	77%	75%	0%	0%	25%
RP/F87V/E267V/L437LV	62%	99%	0%	1%	0%
K19/V78I/F87A/A328I	5%	100%	0%	0%	0%
RT2/A330P/I401M	91%	67%	3%	12%	17%
RT2/A82M/A330P	95%	24%	1%	38%	38%
RT2/I401P	100%	93%	5%	2%	0%
RT2/A330P	87%	57%	3%	11%	29%
RT2/A184I/A330P	100%	23%	2%	18%	56%
RT2/V78I/A330P	6%	71%	0%	0%	29%
RT2	94%	87%	6%	7%	0%
RP/I263A/E267V	100%	62%	5%	3%	29%
WT	1%	100%	0%	0%	0%
RP/A330P	78%	47%	2%	13%	38%
RP/F87V	100%	100%	0%	0%	0%
A330P	0%				
RP/F81W	100%	94%	3%	3%	0%
RT2/S72A/A328I/A330P	73%	64%	2%	11%	23%
RP/H171L/I263G	100%	62%	7%	31%	0%
RT2/P329V/A330P	75%	92%	4%	4%	0%
GVQ	100%	100%	0%	0%	0%
RT2/A330W	56%	94%	6%	0%	0%
F87A	28%	100%	0%	0%	0%
R19/F87A	100%	100%	0%	0%	0%
RP/A82M/I263A	64%	100%	0%	0%	0%
RT2/V78F	30%	74%	14%	11%	0%
R47L/Y51F	2%	100%	0%	0%	0%
K19/A82M/F87A/E267F	24%	100%	0%	0%	0%
RP/H171L	100%	85%	7%	8%	0%
RP/E267G	1%	100%	0%	0%	0%
KSK48	1%	100%	0%	0%	0%
K19/F87V/Q403P	39%	100%	0%	0%	0%
RT2/V78I/A184I/A330P	100%	37%	2%	16%	44%
RP/F87V/L188Q/E267V	48%	100%	0%	0%	0%
RP/V78F/F87V/E267V	54%	100%	0%	0%	0%

RT2/F81W/A328I	24%	89%	5%	6%	0%
RP/E267M	83%	93%	1%	3%	3%
K19/F87V/I263A/A328I	36%	94%	1%	5%	0%
RT2/S72W/A330W	44%	94%	3%	3%	0%
I263G sub-library	**Conversion**	**182**	**183**	**184**	**185**
I263G	71%	65%	3%	29%	3%
H171L/I263G	54%	64%	2%	30%	4%
R1/I263G	94%	63%	4%	29%	4%
RP/H171L/I263G	93%	67%	4%	27%	3%
RP/A82M/I263G	63%	97%	0%	3%	0%
RP/A82W/I263G	13%	100%	0%	0%	0%
R1/A82M/I263G	10%	100%	0%	0%	0%
R1/F87W/I263G	93%	85%	3%	10%	1%
RP/H171L/I263G/L437LV	96%	35%	19%	14%	31%
R1/I263G/L437LV	65%	42%	11%	10%	37%
R1/I263G/L437VL	43%	68%	4%	7%	22%
R1/I263G/L437LM	24%	87%	3%	4%	6%
R1/I263G/L437LA	0%				
R1/I263G/L437LH	0%				
R1/I263G/L437LS	0%				
R1/I263G/L437S	0%				
R1/V78I/I263G/L437LV	60%	51%	7%	10%	32%
R1/V78I/I263G/L437VL	53%	76%	6%	6%	12%
R1/V78I/I263G/L437LM	11%	100%	0%	0%	0%
R1/V78I/I263G/L437LA	5%	62%	0%	0%	38%
R1/V78I/I263G/L437LH	0%				
R1/V78I/I263G/L437LS	3%				
R1/V78I/I263G/L437LI	31%	60%	9%	9%	23%
Mutant (WY1/2)	**Conversion**	**182**	**183**	**184**	**185**
A330P	0%				
A82T/I263R	0%				
GVQ	100%	100%	0%	0%	0%
K19	54%	90%	7%	3%	0%
K19/F87V	100%	100%	0%	0%	0%
K19/F87V/E267V	15%	100%	0%	0%	0%
K19/A82M/F87A/I263G	61%	100%	0%	0%	0%
K19/F87V/A328I	85%	61%	2%	3%	33%
K19/F81W/F87A	87%	100%	0%	0%	0%
K19/F87A/I263A	14%	100%	0%	0%	0%
K19/F87V/Q403P	100%	100%	0%	0%	0%
KU3/A328I/A330P	19%	58%	2%	8%	32%
KU3/S72W/A330P	83%	22%	0%	43%	35%
KU3/V78I/A330P	26%	75%	2%	4%	19%
R19	65%	88%	8%	4%	0%
R19/F87A/A184I	88%	96%	0%	0%	4%
R19/F87A/A328I	45%	83%	0%	3%	13%
R19/F87A	90%	97%	0%	0%	3%
RP/H171L	100%	85%	7%	8%	0%
RT2	92%	90%	10%	0%	0%
RT2/S72G/A330W	0%				
RT2/V78I/A184I/A330P	90%	35%	2%	15%	49%
KU3/A330P	57%	56%	4%	13%	26%
RP/H171L/I263G	100%	60%	5%	34%	0%
A82M/A330P	23%	25%	0%	48%	28%

I263A/A330P	0%				
F81W/T260A	37%	98%	1%	1%	0%
GV/A184I	100%	100%	0%	0%	0%
GVQ/A264G	100%	100%	0%	0%	0%
K19/F87V/A264G	78%	100%	0%	0%	0%
K19/V78I/F87V/E267V	10%	100%	0%	0%	0%
K19/A82M/F87A/E267F	38%	100%	0%	0%	0%
R19/F87A/E267F/A328I	28%	82%	0%	14%	4%
R19/F87A/A328L	27%	86%	0%	14%	0%
R19/S72W/F87A/A328I	25%	75%	0%	7%	19%
R19/V78I/F87A/A328I	19%	97%	0%	3%	0%
R47L/Y51F/I263R	50%	57%	0%	40%	2%
R19/F87A/A328F	84%	95%	0%	5%	0%
R19/F87A/I263G	77%	100%	0%	0%	0%
RP/A82W/I263A	12%	100%	0%	0%	0%
RP/A82M/I263A	66%	100%	0%	0%	0%
RP/F87V	100%	100%	0%	0%	0%
RP/V78I/F87V	44%	90%	3%	1%	6%
RP/H171L/A184I/I263G	92%	72%	6%	22%	0%
RT2/H171L/I263G/A330W	14%	89%	4%	6%	0%
RP/V78I/F87V/H171L/I263G	100%	100%	0%	0%	0%
RP/V78I/E267V	100%	100%	0%	0%	0%
RT2/S72W/A330W	73%	89%	7%	4%	0%

Appendix 3.30: *N*-Boc ε-caprolactam (**188**) by the WY7/8 plates.

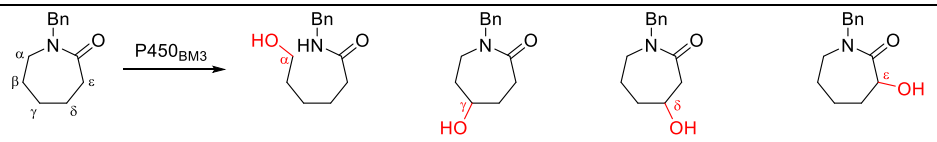


188		189	190	191	192	193
	R19/F87A	42%	-	22%	3%	33%
	K19/F87V	4%	10%	51%	8%	27%

Mutant	conversion	189	190 & 191	192	193
R19/A330W	0%				
K19/F87A/I263G	100%	71%	13%	1%	15%
GVQ	9%	0%	53%	12%	35%
R19/F87I	34%	53%	42%	5%	1%
K19/F87V	64%	17%	53%	7%	24%
K19/F87V/E267V	25%	0%	70%	17%	13%
K19/A82M/F87A/I263G	0%				
K19/F87V/A328V	9%	0%	15%	21%	65%
K19/F81W/F87A	25%	0%	37%	3%	60%
K19/F87A/I263A	6%	0%	23%	2%	75%
K19/F87V/Q403P	38%	0%	75%	10%	15%
KU3/A328I/A330P	0%				
R19/A184I/A328L	0%				
R19/F87A/A328G	83%	63%	4%	2%	31%
R19	14%	0%	19%	9%	72%
R19/F87A/A184I	100%	72%	10%	1%	18%
GVQ/V78L/I263G	73%	80%	4%	0%	16%
R19/F87A	85%	42%	22%	3%	33%
GV/A184I	9%	0%	68%	8%	24%
RT2	49%	0%	35%	8%	57%
R19/F87A/I263G/A264G	77%	0%	23%	2%	76%
RT2/V78I/A184I/A330P	7%	0%	52%	13%	35%
R19/F87A/G265GG	59%	96%	0%	0%	4%
RP/H171L/I263G	86%	0%	90%	1%	10%
RP/I263A/E267V	61%	0%	94%	1%	5%
R19/S72W/F87A/A328I	63%	91%	0%	1%	8%
WT	0%				
GVQ/I263G	100%	27%	16%	1%	55%
GVQ/A264G	6%	0%	0%	0%	100%
K19/F87V/A264G	18%	0%	28%	0%	72%
K19/V78I/F87V/E267V	63%	23%	62%	8%	8%
K19/A82M/F87A/E267F	12%	0%	67%	7%	26%
K19/A82M/F87A	9%	0%	54%	8%	38%
R19/F87A/A328L	3%	0%	0%	14%	86%
R19/F87A/A264G/A328G	43%	93%	0%	0%	7%
R19/V78I/F87A/A328I	2%	0%	0%	0%	100%
R19/F87I/L437LV	67%	0%	93%	7%	0%
GVQ/A330W	95%	66%	10%	1%	24%
R19/F87A/I263G	100%	90%	8%	1%	1%
GVQ/A82M/I263G	51%	100%	0%	0%	0%
RP/A82M/I263A	4%	0%	80%	6%	14%
RP/F87V	10%	75%	20%	2%	3%
RP/V78I/F87V	34%	96%	2%	0%	2%
I263G	36%	45%	44%	0%	11%
GVQ/I263G/A328L	35%	100%	0%	0%	0%

R19/F87A/A328G/P329G/A330G	92%	82%	9%	1%	8%
RP/V78I/E267V	59%	87%	10%	1%	1%
R19/I263A/A328L	0%				

Appendix 3.31: *N*-Benzyl ε-caprolactam (**194**) by the WY7/8 plates and the I263G-sub-library.

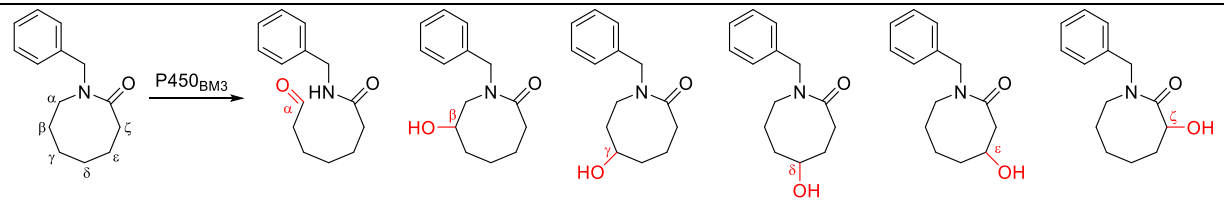


194 | **195** K19/F87V 100%, TON 1,740 | **196** RP/I263G 92%, TON 1,840 | **197** RP/H171L/I263G 9%, TON 180 | **198** RT2/V78I/A184I/A330P 93%, TON 1,050

Mutant	conversion	195	196	197	198
R19/A330W	3%	56%	0%	0%	44%
K19/F87A/I263G	46%	29%	63%	6%	0%
GVQ	71%	100%	0%	0%	0%
R19/F87I	56%	0%	86%	6%	3%
K19/F87V	87%	100%	0%	0%	0%
K19/F87V/E267V	0%				
K19/A82M/F87A/I263G	10%	32%	48%	0%	20%
K19/F87V/A328V	56%	84%	0%	0%	16%
K19/F81W/F87A	45%	99%	0%	1%	0%
K19/F87A/I263A	10%	55%	40%	4%	0%
K19/F87V/Q403P	78%	100%	0%	0%	0%
KU3/A328I/A330P	9%	1%	17%	0%	82%
R19/A184I/A328L	4%	0%	83%	0%	17%
R19/F87A/A328G	43%	100%	0%	0%	0%
R19	42%	64%	30%	0%	7%
R19/F87A/A184I	94%	92%	8%	0%	0%
GVQ/V78L/I263G	37%	0%	92%	2%	4%
R19/F87A	84%	100%	0%	0%	0%
GV/A184I	46%	100%	0%	0%	0%
RT2	92%	48%	44%	1%	7%
R19/F87A/I263G/A264G	18%	35%	58%	7%	0%
RT2/V78I/A184I/A330P	56%	2%	3%	2%	93%
R19/F87A/G265GG	16%	47%	37%	5%	11%
RP/H171L/I263G	95%	0%	91%	9%	0%
RP/I263A/E267V	16%	0%	80%	8%	11%
R19/S72W/F87A/A328I	19%	24%	5%	8%	61%
WT	4%	38%	38%	0%	24%
GVQ/I263G	75%	0%	92%	3%	1%
GVQ/A264G	100%	0%	0%	0%	0%
K19/F87V/A264G	51%	100%	0%	0%	0%
K19/V78I/F87V/E267V	5%	88%	12%	0%	0%
K19/A82M/F87A/E267F	17%	38%	23%	6%	33%
K19/A82M/F87A	55%	64%	16%	3%	17%
R19/F87A/A328L	5%	0%	13%	35%	51%
R19/F87A/A264G/A328G	2%	100%	0%	0%	0%
R19/V78I/F87A/A328I	11%	6%	63%	10%	21%
R19/F87I/L437LV	30%	23%	73%	4%	0%
GVQ/A330W	86%	100%	0%	0%	0%
R19/F87A/I263G	45%	34%	60%	6%	0%
GVQ/A82M/I263G	4%	0%	100%	0%	0%
RP/A82M/I263A	8%	50%	13%	0%	37%
RP/F87V	3%	4%	96%	0%	0%
RP/V78I/F87V	2%	50%	50%	0%	0%
I263G	46%	0%	93%	7%	0%
GVQ/I263G/A328L	0%				

R19/F87A/A328G/P329G/A330G	26%	100%	0%	0%	0%
RP/V78I/E267V	55%	100%	0%	0%	0%
R19/I263A/A328L	2%	0%	100%	0%	0%
I263G sub-library					
I263G	62%	0%	93%	7%	1%
H171L/I263G	43%	0%	91%	9%	0%
R1/I263G	93%	0%	91%	9%	0%
RP/I263G	100%	0%	92%	5%	0%
RP/H171L/I263G/L437LV	99%	63%	20%	6%	5%
R1/I263G/K202KPG	64%	0%	91%	9%	0%
R1/I263G/R398H	62%	0%	94%	5%	0%
R1/I263G/L437LV	36%	56%	17%	6%	8%
R1/I263G/L437VL	69%	65%	19%	7%	4%
R1/I263G/L437LF	9%	11%	88%	0%	0%
R1/I263G/L437LS	7%	19%	74%	7%	0%
R1/I263G/L437LH	6%	16%	82%	0%	0%
R1/I263G/L437S	3%	0%	100%	0%	0%
RP/S72W/H171L/I263G	27%	2%	88%	10%	0%
RP/V78F/H171L/I263G	0%				
RP/V78I/H171L/I263G	0%				
RP/H171L/A184I/I263G	96%	0%	86%	10%	0%
RP/H171L/I263G/P329G	3%	0%	100%	0%	0%
RP/H171L	95%	45%	44%	0%	10%

Appendix 3.32: *N*-Benzyl ζ-enantholactam (**199**) by the WY9 plate and the Gly-sub-library.



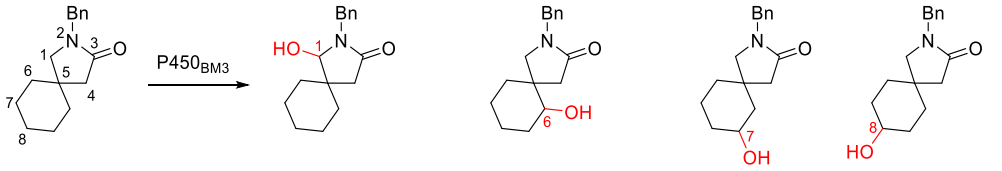
199 | **200** R19/F87A 78%, TON 1,380 | **201** RT2 30%, TON 230 | **202** R19/F87I 75%, TON 1,460 | **203** K19/F87V/Q403P 78%, TON 440 | **204** K19/F87V/A328V 38%, TON 340 | **205** K19/F87V/A328V 16%, TON 140

Mutant (16 h)	**conv.**	**200**	**201**	**202**	**203**	**204**	**205**
R19/A330W	5%	0%	56%	15%	23%	5%	0%
K19/F87V/I263G	10%	1%	1%	25%	70%	3%	1%
GVQ	31%	84%	0%	0%	0%	16%	0%
R19/F87I	100%	2%	0%	75%	23%	0%	1%
K19/F87V	75%	37%	8%	17%	29%	9%	0%
R19/F87A/A328G/P329G/A330G	29%	67%	9%	2%	7%	16%	0%
K19/A82M/F87A/I263G	4%	0%	2%	17%	79%	2%	0%
K19/F87V/A328V	44%	0%	3%	5%	38%	38%	16%
K19/F81W/F87A	7%	0%	2%	9%	80%	9%	0%
K19/F87A/I263A	8%	0%	0%	20%	68%	12%	0%
K19/F87V/Q403P	28%	0%	2%	14%	78%	6%	0%
KU3/A328I/A330P	0%	0%	0%	0%	0%	0%	0%
RP/V78I/E267V	39%	0%	2%	9%	85%	4%	0%
R19/F87A/A328G	7%	0%	1%	4%	94%	2%	0%
R19/I263A/A328L	0%	0%	0%	0%	100%	0%	0%
R19/F87A/A184I	100%	19%	5%	16%	53%	7%	0%
GVQ/V78L/I263G	8%	0%	1%	40%	58%	1%	0%
R19/F87A	88%	78%	0%	5%	5%	11%	0%
GV/A184I	100%	5%	5%	29%	55%	6%	0%
RT2	38%	0%	30%	17%	43%	10%	0%

R19/F87A/I263G/A264G	5%	0%	2%	23%	66%	10%	0%
K19/A82M/F87A/A330W	57%	0%	15%	24%	51%	8%	3%
R19/F87A/G265GG	10%	0%	4%	9%	77%	10%	0%
GVQ/I263G/A328L	20%	0%	0%	0%	53%	47%	0%
Gly-sub-library (3 h)	**conv.**	**200**	**201**	**202**	**203**	**204**	**205**
GV/A184I/T260G	1%	0%	0%	0%	52%	48%	0%
GV/A184I/T260G/A328G	0%						
GVQ/T260G	0%						
K19/A82M/F87A/T260G/A328G	18%	43%	22%	4%	24%	7%	0%
R19/F87A/A184I/T260G/A328G	29%	69%	4%	3%	20%	4%	0%
R19/F81W/F87A/T260G/A328G	8%	69%	9%	8%	5%	9%	0%
R19/F87A/T260G/A328G/P329G/A330G	7%	70%	9%	4%	6%	12%	0%
R19/F87A/T260G/P329G/A330W	18%	75%	0%	3%	13%	10%	0%
R19/F87A/I259G/I263G	0%						
R19/F87A/A184I/I259G/I263G	0%						
R19/F87A/I259G/I263G/A328G	17%	0%	1%	17%	76%	4%	1%
R19/F87A/T260G/A328G	3%	100%	0%	0%	0%	0%	0%
R19/F87A/L262G/A328G	10%	73%	10%	7%	4%	5%	0%
R19/F87A/T269G/A328G	49%	69%	2%	2%	23%	3%	0%
R19/F87A/S270G/A328G	42%	73%	3%	3%	16%	4%	0%
R19/F87A/V78I/A184I/A328I	1%	0%	0%	0%	32%	68%	0%
R19/F87A/T260G	1%	0%	24%	3%	19%	54%	0%
R19/F87A/L262G	26%	55%	7%	6%	26%	6%	0%
R19/F87A/T269G	51%	66%	3%	5%	21%	6%	0%
R19/F87A/S270G	23%	58%	4%	6%	21%	10%	0%
R19/F87A/A184I/T260G	37%	64%	4%	3%	22%	6%	0%
R19/F87A/A184I/L262G	20%	44%	5%	12%	30%	9%	0%
R19/F87A/A184I/T269G	44%	38%	3%	14%	40%	6%	0%
R19/F87A/A184I/S270G	74%	41%	3%	15%	35%	7%	0%

R19/F87A/I263G/A328G	4%	0%	2%	23%	72%	3%	0%
GVQ/A328G	2%	0%	40%	33%	10%	18%	0%
GVQ/I263G/A264G/A328G	0%						
R19/F87A/A184I/A264G	30%	29%	2%	18%	42%	8%	0%
R19/F87A/A184I/I263G/A264G	3%	0%	0%	19%	68%	13%	0%
R19/F87A/A184I/I263G/A328G	3%	0%	3%	22%	67%	4%	5%
R19/F87A/A184I/A264G/A328G	1%	0%	14%	25%	54%	7%	0%
R19/F87A/A184I/I263G/A264G/A328G	3%	0%	4%	20%	67%	9%	0%
GV/A184I/I263G	12%	0%	0%	27%	70%	1%	1%
GV/A184I/A264G	79%	2%	11%	27%	40%	20%	1%
GV/A184I/A328G	1%	0%	31%	34%	27%	7%	0%
GV/A184I/I263G/A328G	0%						
GV/A184I/A264G/A328G	0%						
GV/A184I/I263G/A264G/A328G	0%						
K19/A82M/F87A/A264G	22%	0%	8%	6%	62%	10%	14%
K19/A82M/F87A/I263G/A264G	17%	0%	3%	9%	84%	4%	1%
K19/A82M/F87A/I263G/A328G	31%	1%	6%	47%	45%	0%	1%
K19/A82M/F87A/A264G/A328G	20%	0%	80%	5%	9%	3%	3%
K19/A82M/F87A/I263G/A264G/A328G	16%	0%	42%	15%	40%	2%	0%
K19/F87V/I263G	5%	0%	0%	19%	81%	0%	0%
R19/F87A/ A328G/P329G/A330G	24%	65%	4%	2%	20%	9%	0%
R19/F87A/ W90V	11%	31%	2%	5%	57%	5%	0%
K19/F87V/A184I	0%						
K19/F87V/A264G	13%	44%	7%	12%	16%	20%	0%

Appendix 3.33: *N*-Benzyl 2-azaspiro[4.5]decan-3-one (**206**) by the WY9 plate and the expanded library.



206

207
R19/S72P/A330W
90%, TON 1,170

208
R19/A328G/P329G/A330G
35%, TON 690
5*R*,6*R*/5*S*,6*S* dominant
5*R*,6*S*/5*S*,6*R* minor

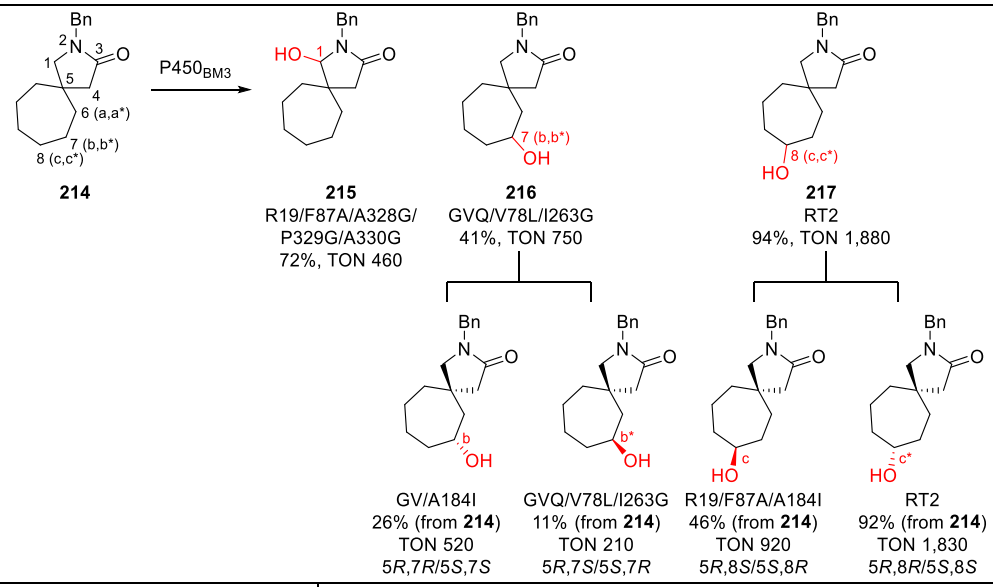
209
GVQ/V78L/I263G
70%, TON 330

210
R19/I263G
81%, TON 1,280

Mutant (3 h)	**conversion**	**207**	**208**	**209**	**210**
R19/A330W	4%	62%			38%
K19/F87V/I263G	20%		10%	63%	26%
GVQ	2%	62%		27%	11%
R19/F87I	20%		21%	30%	49%
K19/F87V	49%	26%	3%	9%	62%
R19/F87A//A328G/P329G/A330G	9%	76%	4%	5%	15%
K19/A82M/F87A/I263G	0%				
K19/F87V/A328V	44%		4%	3%	93%
K19/F87A/F81W	2%	52%		18%	30%
K19/F87A/I263A	1%			30%	70%
K19/F87V/Q403P	54%	25%	4%	9%	61%
KU3/A328I/A330P	0%				
RP/V78I/E267V	13%	11%	4%	9%	76%
R19/F87A//A328G	9%	100%			
R19/I263A/A328L	6%		34%		66%
R19/F87A//A184I	91%	15%	1%	24%	60%
GVQ/V78L/I263G	24%		6%	70%	24%
R19/F87A	54%	47%		20%	33%
GV/A184I	95%	6%	3%	18%	73%
RT2	74%	26%	7%	1%	66%
R19/F87A/I263G/A264G	6%			20%	80%
K19/F87A/A82M/A330W	2%				100%
R19/F87A/G265GG	4%	11%	2%	34%	54%
GVQ/I263G/A328L	0%				
expanded library (16 h)	**conversion**	**207**	**208**	**209**	**210**
R19/A184I/T260G	15%	54%	3%	4%	39%
R19/F87I	67%	1%	24%	30%	45%
R19/I263G/A264G/A328G	0%				
R19/I263W/A328G	2%	100%			
R19/A328G/P329G/A330G	100%	27%	35%		38%
R19/T260G/Y278HA328G/P329G/A330G	0%				
R19/T260G/A328G	19%	74%	14%		12%
R19/I263G	79%	0%	1%	18%	80%
R19/I263G/A328G	3%				100%
R19/P329G/A330W	92%	82%	2%		16%
R19/T260G	0%				
R19/A82M/A184I/T260G	70%	18%		6%	76%
K19/A82M/A264G/A328G	0%				
R19/A82M/I263G/A264G/A328G	16%	100%			
R19/A82M/I263W/A328G	0%				
R19	90%	22%	5%	1%	72%
R19/A82M/T260G/A328G/P329G/A330G	0%				
R19/A330W	8%	60%			40%

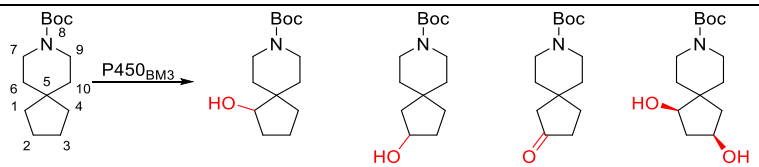
R19/A82M/G265GG	0%				
R19/A82M/I263G	0%				
R19/A82M/I263G/A328G	5%	100%			
R19/A82M/P329G/A330W	4%	19%			81%
R19/A82M/T260G	18%	15%			85%
RT2/I263A/A330W	7%	32%			68%
RP/I263A/A330W	0%				
RP/S72G/H171L/I263G	6%				100%
LQ/S72A/I263G/A328G	2%			100%	
RT2/S72Y/A330W	86%	30%	2%	0%	68%
S72H/F87L/L188Q/I263G/A328G	0%				
RP/A82M/I263A/A330W	27%	24%			76%
GLQ/S72W/I263G	15%		38%	40%	22%
RP/H171L/I263G/S72W	19%		2%	7%	91%
R19/A330S	0%				
S72V/F87V/L188Q/A330W	13%	68%			32%
S72P/F87V/L188Q/A330W	17%	76%	3%		21%
S72W/F87V/L188Q/A330W	41%	35%	5%	6%	54%
R19/S72G/A330W	56%	64%			36%
R19/S72A/A330W	79%	64%			36%
R19/S72L/A330W	21%	70%			30%
R19/S72H/A330W	28%	29%			71%
R19/S72P/A330W	65%	90%			10%
R19/S72W/A330W	34%	17%			83%
R19/S72V/A330W	56%	85%			15%
K19/A82M/F87A/A330W	0%				
R19/I263V/A330W	0%				
GVQ/I263G/A328L	0%				
RP/I263A/A330W	0%				

Appendix 3.34: *N*-Benzyl 2-azaspiro[4.6]undecan-3-one (**214**) by the WY9 plate.



Mutant	Conv.	215	216 (b)	216 (b*)	217 (c)	217 (c*)
R19/A330W	11%	10%				63%
K19/F87V/I263G	42%		20%	7%	17%	53%
GVQ	10%	17%	1%		31%	21%
R19/F87I	88%		7%	5%	34%	53%
K19/F87V	88%	2%	12%	3%	6%	77%
R19/F87A//A328G/P329G/A330G	32%	72%	12%		2%	8%
K19/A82M/F87A/I263G	3%					
K19/F87V/A328V	79%		9%	2%	3%	83%
K19/F87A/F81W	3%					
K19/F87A/I263A	3%					
K19/F87V/Q403P	84%	2%	13%	3%	5%	77%
KU3/A328I/A330P	3%					
RP/V78I/E267V	87%	0%	11%	3%	5%	80%
R19/F87A//A328G	23%	45%			8%	39%
R19/I263A/A328L	39%		27%		2%	63%
R19/F87A//A184I	100%	1%	8%	2%	46%	43%
GVQ/V78L/I263G	91%		26%	11%	17%	41%
R19/F87A	57%	13%	6%	4%	41%	34%
GV/A184I	100%		26%	2%	4%	67%
RT2	100%		4%	3%	2%	92%
R19/F87A/I263G/A264G	6%			14%	9%	19%
K19/F87A/A82M/A330W	8%	2%	20%		8%	20%
R19/F87A/G265GG	12%	4%		5%	46%	18%
GVQ/I263G/A328L	5%		27%			13%

Appendix 3.35: *N*-Boc 8-azaspiro[4.5]decane (**224**) by the TFA1/B1 plates.

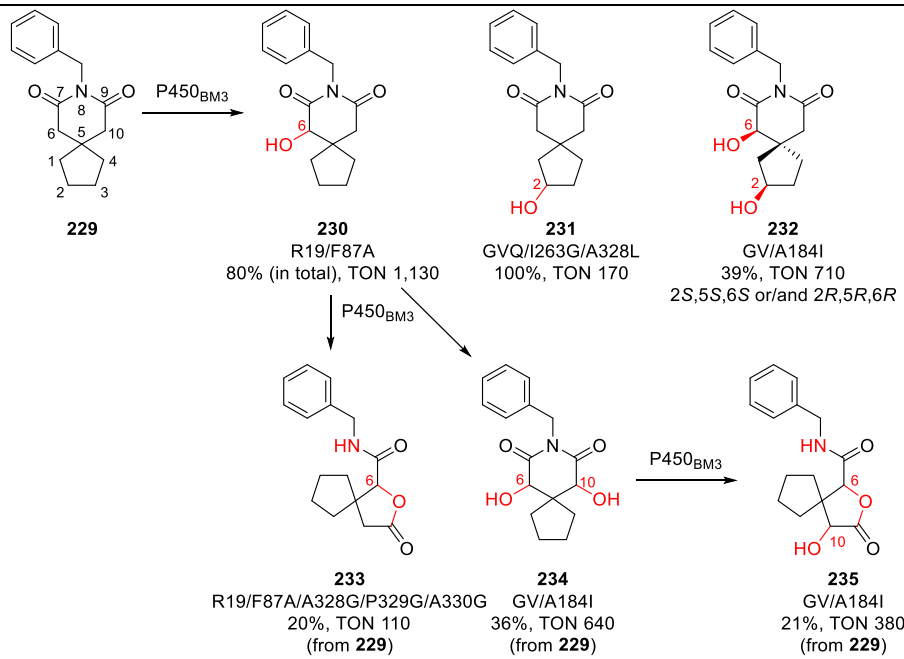


224 **225** **226** **227** **228** *syn*

Mutant	conv.	225	226	227	228
R19/F87A/A328I	82%	48%	49%	2%	0%
K19/A82M/F87A	54%	98%	0%	2%	0%
K19/Y51L/F87A/A328I	18%	100%	0%	0%	0%
K19/F87A/A184I/A328I	0%				
R19/F87I	92%	18%	79%	3%	0%
K19/F87A/I263A	85%	94%	4%	1%	1%
RP	96%	58%	41%	1%	0%
RP/E267V	13%	100%	0%	0%	0%
RT2/F81W	69%	57%	42%	1%	0%
RP/F87V/E267V	96%	42%	44%	4%	8%
K19/F87V/A328I	0%				
RP/F87V/E267V/L437LV	0%				
K19/F87A/I263G	0%				
RT2/A330P/I401M	0%				
RT2/A82M/A330P	24%	100%	0%	0%	0%
RT2/I401P	82%	44%	54%	1%	0%
RT2/A330P	0%				
RT2/A184I/A330P	3%	100%	0%	0%	0%
RT2/V78I/A330P	0%				
RT2	98%	40%	59%	1%	0%
RP/I263A/E267V	15%	100%	0%	0%	0%
WT	0%				
RP/A330P	0%				
RP/F87V	98%	32%	27%	17%	20%
A330P	3%	100%	0%	0%	0%
RP/H171L/I263A/E267V	9%	100%	0%	0%	0%
RT2/S72A/A328I/A330P	9%	100%	0%	0%	0%
RP/H171L/I263G	45%	33%	61%	6%	0%
GVQ/I263G	49%	0%	98%	2%	0%
GVQ	21%	100%	0%	0%	0%
RT2/A330W	60%	69%	0%	0%	0%
F87A	26%	100%	0%	0%	0%
R19/F87A	94%	86%	11%	0%	1%
RP/A82M/I263A	36%	92%	8%	0%	0%
RP/H171L/I263G/E267V	4%	100%	0%	0%	0%
R47L/Y51F	95%	44%	55%	1%	0%
K19/A82M/F87A/E267F	8%	100%	0%	0%	0%
RP/V78F/F87V/E267V/L437LV	26%	96%	0%	3%	0%

RP/E267G	39%	15%	85%	0%	0%
KSK48	3%	100%	0%	0%	0%
K19/F87V/Q403P	26%	100%	0%	0%	0%
RT2/V78I/A184I/A330P	5%	100%	0%	0%	0%
RP/F87V/L188Q/E267V	55%	52%	47%	1%	0%
RP/V78F/F87V/E267V	69%	59%	37%	3%	1%
RT2/F81W/A328I	40%	0%	97%	2%	0%
RP/E267M	9%	100%	0%	0%	0%
K19/F87A/I263A/A328I	89%	43%	54%	3%	0%
RT2/S72W/A330W	10%	98%	0%	2%	0%

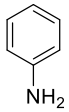
Appendix 3.36: *N*-Boc 8-azaspiro[4.5]decane (**229**) by the WY9 plate.



Mutant	conv.	230	231	232	233	234	235
R19/A330W	0%						
K19/F87V/I263G	65%	15%	25%	28%	5%	19%	8%
GVQ	5%	98%			2%		
R19/F87I	36%	42%	32%	5%	16%		
K19/F87V	68%	35%	5%	33%	11%		15%
R19/F87A/A328G/P329G/A330G	28%	64%	16%		20%		
K19/A82M/F87A/I263G	0%						
K19/F87V/A328V	19%	72%	8%		20%		
K19/F81W/F87A	14%	72%	5%		23%		
K19/F87A/I263A	13%	63%	7%		24%		
K19/F87V/Q403P	64%	40%	5%		13%		15%
KU3/A328I/A330P	0%						
RP/V78I/E267V	35%	46%	24%		15%		
R19/F87A/A328G	21%	74%	5%		21%		
R19/I263A/A328L	3%		100%				
R19/F87A/A184I	61%	54%	6%	12%	15%	9%	4%
GVQ/V78L/I263G	63%	16%	33%	20%	6%	17%	9%
R19/F87A	71%	46%	5%		13%	7%	13%
GV/A184I	91%	15%	6%	39%	5%	14%	21%
RT2	29%	46%	41%		14%		
R19/F87A/I263G/A264G	90%	10%	22%	20%	4%	8%	
K19/A82M/F87A/A330W	9%	13%	37%		5%		
R19/F87A/G265GG	3%	51%	49%				
GVQ/I263G/A328L	8%		100%				

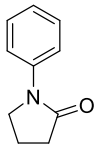
Appendix 4 NMR and MS characterisation of the products from $P450_{BM3}$ oxidation.

Appendix 4.1 The NMR and MS data of the products in Chapter 3.



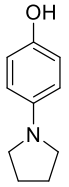
2

The titled compound (**2**)[1] was obtained as brown liquid (2.0 mg, 2% yield) using the described general method [from **1** (1.0 mmol) and the mutant R19/F87A/A328I (0.50 μmol) in phosphate buffer, 100 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (400 MHz; $CDCl_3$) δ 6.68 (d, *J* = 7.8 Hz, 2H), 6.74–6.77 (t, *J* = 7.29 Hz, 1H), 7.14–7.17 (t, *J* = 7.71 Hz, 1H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 115.09, 118.55, 129.25, 146.31. HMRS (ESI^+) calc. for C_6H_8N $[M+H]^+$ 94.0651, found 94.0670.



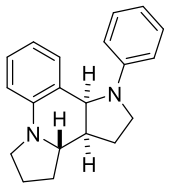
3

The titled compound (**3**)[2] was obtained as white solid (1.0 mg, 0.7% yield) using the described general method [from **1** (1.0 mmol) and the mutant R19/F87A/A328I (0.50 μmol) in phosphate buffer, 100 mL reaction volume] and purification by prep TLC. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.64–7.58 (m, 1H), 7.37 (t, *J* = 7.9 Hz, 1H), 7.15 (t, *J* = 7.4 Hz, 1H), 3.87 (t, *J* = 7.0 Hz, 1H), 2.62 (t, *J* = 8.1 Hz, 1H), 2.17 (p, *J* = 7.6 Hz, 1H). ^{13}C NMR (126 MHz, $CDCl_3$): δ 174.2, 139.4, 128.8 (2C), 124.5, 120.0 (2C), 48.8, 32.8, 18.0. HMRS (ESI^+) calc. for $C_{10}H_{12}NO$ $[M+H]^+$ 162.0913, found 162.0914.



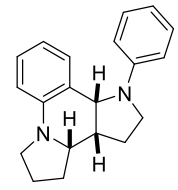
4

The titled compound (**4**)[3] was obtained as white solid (52.4 mg, 36% yield) using the described general method [from **1** (1.0 mmol) and the mutant RP/H171L/I263G (0.50 μmol) in phosphate buffer, 100 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (400 MHz, CD_3OD) δ 6.67 (d, *J* = 8.9 Hz, 1H), 6.50 (d, *J* = 8.9 Hz, 1H), 3.20–3.13 (m, 2H), 2.01–1.94 (m, 2H). HMRS (ESI^+) calc. for $C_{10}H_{14}NO$ $[M+H]^+$ 164.1070, found 164.1070.



5

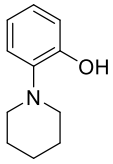
The titled compound (**5**)[4] was obtained as light yellow solid (10.5 mg, 7% yield) using the described general method [from **1** (1.0 mmol) and the mutant R19/F87A/A328I (0.50 μmol) in phosphate buffer, 100 mL reaction volume] and purification by prep TLC. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.23–7.08 (m, 3H), 6.84–6.61 (m, 5H), 4.45 (d, *J* = 9.2 Hz, 1H), 3.66 (t, *J* = 8.4 Hz, 1H), 3.46 (td, *J* = 9.0, 3.0 Hz, 1H), 3.33 (td, *J* = 9.9, 6.4 Hz, 1H), 2.86 (q, *J* = 8.9 Hz, 1H), 2.81–2.72 (m, 1H), 2.46 (dt, *J* = 10.2, 6.9 Hz, 1H), 2.19 (ddt, *J* = 38.8, 19.9, 10.4 Hz, 2H), 2.04 – 1.92 (m, 1H), 1.78 (ddt, *J* = 17.7, 11.4, 5.3 Hz, 2H) with the assignment of the relative stereochemistry confirmed by COSY, HSQC and NOSEY correlations (Spectra 3–5), which is consistent with literature data.[5] ^{13}C NMR (126 MHz, $CDCl_3$) δ 149.22, 147.18, 129.09, 128.31, 127.21, 127.03, 118.91, 116.49, 112.73, 112.13, 64.66, 59.50, 49.18, 48.27, 47.31, 32.03, 30.60, 22.35. HMRS (ESI^+) calc. for $C_{20}H_{23}N_2$ $[M+H]^+$ 291.1856, found 291.1856.



6

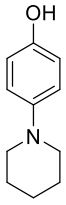
The titled compound (**6**)[5] was obtained as light yellow solid (14.7 mg, 10% yield) using the described general method [from **1** (1.0 mmol) and the mutant R19/F87A/A328I (0.50 μmol) in phosphate buffer, 100 mL reaction volume] and purification by prep TLC. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.33 – 7.27 (m, 2H), 7.11–7.06 (m, 1H), 6.81 (d, *J* = 8.1 Hz, 2H), 6.69 (t, *J* = 7.3 Hz, 1H), 6.54–6.47 (m, 1H), 6.39 (d, *J* = 8.1 Hz, 1H), 5.11 (d, *J* = 6.9 Hz, 1H), 3.77–3.69 (m, 1H), 3.44 (t, *J* = 8.9 Hz, 1H), 3.36 (q, *J* = 8.4 Hz, 1H), 3.32–3.21 (m, 2H), 2.50 (ddd, *J* = 12.9, 6.4, 3.3 Hz, 1H), 2.10 (t, *J* = 9.3 Hz, 1H), 2.06–1.90 (m, 2H), 1.85 (p, *J* = 11.5 Hz, 1H), 1.74–1.63 (m, 1H) with the assignment of the relative stereochemistry confirmed by COSY and NOSEY correlations (Spectra 8–10), which is consistent with literature data.[5] ^{13}C

NMR (126 MHz, $CDCl_3$) δ 148.80, 143.13, 129.31, 128.78, 128.02, 122.93, 115.77, 115.38, 111.21, 110.22, 57.42, 56.42, 47.39, 46.58, 40.06, 30.21, 23.30, 23.21. HMRS (ESI^+) calc. for $C_{20}H_{23}N_2$ $[M+H]^+$ 291.1856, found 291.1856.



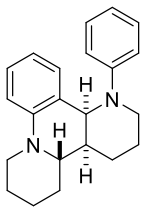
8

The titled compound (**8**)[6] was obtained as white solid (32.4 mg, 20% yield) using the described general method [from **7** (1.0 mmol) and the mutant RP/H171L/I263G (0.50 μmol) in phosphate buffer, 100 mL reaction volume] and purification by silica gel chromatography. ^1H NMR (400 MHz, $CDCl_3$) δ 7.14 (dd, *J* = 7.8, 1.4 Hz, 1H), 7.05 (td, *J* = 7.9, 1.5 Hz, 1H), 6.93 (dd, *J* = 8.0, 1.4 Hz, 1H), 6.84 (td, *J* = 7.6, 1.4 Hz, 1H), 2.80 (t, *J* = 5.4 Hz, 4H), 1.74 (m, 4H), 1.60 (d, *J* = 5.0 Hz, 2H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 151.5, 140.4, 126.0, 121.3, 119.8, 113.7, 54.1, 26.8, 23.9. HMRS (ESI^+) calc. for $C_{11}H_{16}NO$ $[M+H]^+$ 178.1226, found 178.1226.



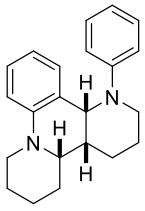
9

The titled compound (**9**)[7] was obtained as white solid (2.3 mg, 1.4% yield) using the described general method [from **7** (1.0 mmol) and the mutant RT2/S72W/A330W (0.50 μmol) in phosphate buffer, 100 mL reaction volume] and purification by silica gel chromatography. ^1H NMR (500 MHz, $CDCl_3$) δ 6.86 (d, *J* = 8.9 Hz, 2H), 6.75 (d, *J* = 8.9 Hz, 2H), 4.42 (br, 1H), 3.01 (t, *J* = 5.5 Hz, 4H), 1.80–1.68 (m, 4H), 1.58–1.50 (m, 2H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 149.40, 147.23, 119.12, 115.84, 52.51, 26.28, 24.32. HMRS (ESI^+) calc. for $C_{11}H_{16}NO$ $[M+H]^+$ 178.1226, found 178.1226.



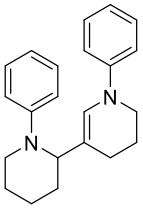
10

The titled compound (**10**) was obtained as white solid (29.4 mg in the 52.4 mg mixture of **10** and **11** <spectra 11–14>, 18% yield) using the described general method [from **7** (1.0 mmol) and the mutant R19/F87A/A328I (0.50 μmol) in phosphate buffer, 100 mL reaction volume] and purification by silica gel chromatography. ^1H NMR (500 MHz, $CDCl_3$) δ 7.22 (t, *J* = 7.2 Hz, 2H), 7.13 – 7.10 (m, 1H), 7.07 (dt, *J* = 7.6, 1.5 Hz, 1H), 6.94 (d, *J* = 8.0 Hz, 2H), 6.76 (d, *J* = 8.3 Hz, 1H), 6.71 (t, *J* = 7.3 Hz, 1H), 6.64 (d, *J* = 7.7 Hz, 1H), 5.01 (d, *J* = 5.3 Hz, 1H), 3.91 (dt, *J* = 13.1, 3.4, 2.9 Hz, 1H), 3.72 (dt, *J* = 12.8, 4.8, 3.1 Hz, 1H), 3.12 (td, *J* = 12.5, 3.1 Hz, 1H), 2.73 (dt, *J* = 11.6, 2.4 Hz, 1H), 2.01 – 1.97 (m, 1H), 1.92 – 1.87 (m, 1H), 1.72 – 1.53 (m, 7H), 1.43 – 1.36 (m, 1H), 1.29 – 1.24 (m, 1H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 151.16, 146.08, 129.50, 127.77, 127.41, 123.12, 117.03, 116.99, 114.09, 114.03, 111.85, 63.48, 53.65, 48.48, 42.35, 40.50, 32.32, 29.86, 27.33, 25.63, 25.26. The relative stereochemistry was confirmed by the COSY NMR (Spectra 13 and 17). HMRS (ESI^+) calc. for $C_{22}H_{27}N_2$ $[M+H]^+$ 319.2169, found 319.2.



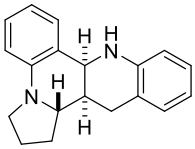
11

The titled compound (**11**) was obtained as white solid (29.4 mg in the 52.4 mg mixture of **10** and **11** <spectra 11–14>, 18% yield) using the described general method [from **7** (1.0 mmol) and the mutant R19/F87A/A328I (0.50 μmol) in phosphate buffer, 100 mL reaction volume] and purification by silica gel chromatography. ^1H NMR (500 MHz, Chloroform-*d*) δ 7.24 (d, *J* = 6.6 Hz, 2H), 7.17–7.12 (m, 2H), 6.94 (d, *J* = 7.9 Hz, 2H), 6.89 (d, *J* = 8.3 Hz, 1H), 6.71 (t, *J* = 7.3 Hz, 1H), 6.67 (t, *J* = 7.1 Hz, 1H), 5.22 (d, *J* = 4.9 Hz, 1H), 3.99 (d, *J* = 12.2 Hz, 1H), 3.63 (d, *J* = 13.8 Hz, 1H), 3.04 (dt, *J* = 11.5, 2.8 Hz, 1H), 2.97 (ddd, *J* = 13.5, 11.7, 3.6 Hz, 1H), 2.60 (td, *J* = 12.3, 2.8 Hz, 1H), 1.99–1.94 (m, 1H), 1.87–1.77 (m, 3H), 1.72–1.52 (m, 6H), 1.48 (td, *J* = 12.5, 4.1 Hz, 1H). ^{13}C NMR (126 MHz, Chloroform-*d*) δ 148.06, 129.59, 129.50, 127.86, 127.83, 123.28, 118.35, 116.94, 114.12, 114.09, 61.05, 57.61, 49.32, 41.74, 38.43, 26.44, 24.75, 24.50, 24.43, 20.64. The relative stereochemistry was confirmed by the COSY NMR (Spectra 13 and 21). HMRS (ESI^+) calc. for $C_{22}H_{27}N_2$ $[M+H]^+$ 319.2169, found 319.2.



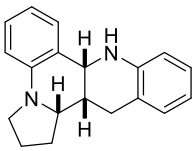
12

The titled compound (**12**) was obtained as white solid (1.0 mg in the 1.2 mg mixture of **12** and the enamine of **7** <spectra 23 and 24>, 0.6% yield) using the described general method [from **7** (1.0 mmol) and the mutant R19/F87A/A328I (0.50 μmol) in phosphate buffer, 100 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (400 MHz, C_6D_6) δ 7.23–7.18 (m, 2H), 7.17–7.13 (m, 2H), 7.01 (dd, *J* = 7.7, 1.0 Hz, 2H), 6.86 (ddt, *J* = 7.3, 1.5 Hz, 1H), 6.78 (ddt, *J* = 7.3, 1.0 Hz, 1H), 6.69 (dt, *J* = 7.8, 0.8 Hz, 2H), 6.48 (d, *J* = 1.3 Hz, 1H), 3.71 (dd, *J* = 7.2, 3.2 Hz, 1H), 3.17 (ddd, *J* = 12.2, 6.7, 3.8 Hz, 1H), 3.08–3.03 (m, 1H), 3.01 (dt, *J* = 10.3, 3.5 Hz, 1H), 2.97–2.92 (m, 1H), 1.87 (dt, *J* = 11.0, 6.3 Hz, 2H), 1.77 (td, *J* = 9.5, 8.9, 7.6 Hz, 1H), 1.69–1.58 (m, 2H), 1.58–1.45 (m, 3H), 1.45–1.39 (m, 1H), 1.38–1.32 (m, 1H). HMRS (ESI$^+$) calc. for $C_{22}H_{27}N_2$ $[M+H]^+$ 319.2169, found 319.2.



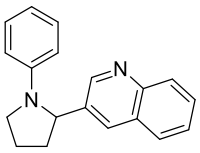
14

The titled compound (**14**) was obtained as white solid (15.4 mg, 11%) using the described general method [from **1** (0.50 mmol) and **13** (0.50 mmol) and the mutant R19/F87A/A328I (0.50 μmol) in phosphate buffer, 100 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.26 (ddd, *J* = 8.0, 7.3, 1.7 Hz, 1H), 7.20 (dd, *J* = 7.3, 1.6 Hz, 1H), 7.08–7.02 (m, 2H), 6.71–6.63 (m, 2H), 6.52 (dd, *J* = 8.2, 1.1 Hz, 1H), 6.46 (dd, *J* = 8.0, 1.2 Hz, 1H), 4.42 (d, *J* = 2.9 Hz, 1H), 3.84 (s, 1H), 3.55 (td, *J* = 10.8, 5.0 Hz, 1H), 3.47 (td, *J* = 9.1, 1.6 Hz, 1H), 3.33 (dd, *J* = 9.8, 7.5 Hz, 1H), 3.31–3.24 (m, 1H), 2.80 (dd, *J* = 16.9, 1.6 Hz, 1H), 2.28–2.20 (m, 1H), 2.20–2.10 (m, 1H), 2.01–1.88 (m, 2H), 1.59 (ddd, *J* = 11.1, 5.6, 3.5 Hz, 1H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 143.85, 142.00, 129.65, 129.56, 128.91, 127.34, 122.37, 118.36, 117.25, 114.62, 114.00, 110.46, 55.62, 52.33, 47.32, 34.29, 32.00, 29.24, 24.02. HMRS (ESI$^+$) calc. for $C_{19}H_{21}N_2$ $[M+H]^+$ 277.1699, found 277.1699.



15

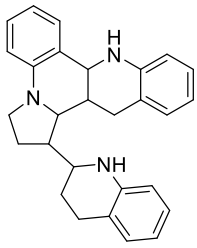
The titled compound (**15**) was obtained as white solid (25.0 mg, 18%) using the described general method [from **1** (0.50 mmol) and **13** (0.50 mmol) and the mutant R19/F87A/A328I (0.50 μmol) in phosphate buffer, 100 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.16 (dt, *J* = 7.5, 1.4 Hz, 1H), 7.05 (dddd, *J* = 8.0, 7.3, 1.7, 0.8 Hz, 1H), 6.99–6.93 (m, 1H), 6.85 (dt, *J* = 7.5, 1.3 Hz, 1H), 6.63 (dd, *J* = 7.9, 1.2 Hz, 1H), 6.55 (tdd, *J* = 7.3, 5.9, 1.2 Hz, 2H), 6.34 (dd, *J* = 8.1, 1.1 Hz, 1H), 4.72 (s, 1H), 4.64–4.59 (m, 1H), 3.93 (ddd, *J* = 10.7, 5.0, 2.9 Hz, 1H), 3.40 (td, *J* = 8.8, 1.7 Hz, 1H), 3.20 (td, *J* = 8.9, 7.1 Hz, 1H), 2.62–2.54 (m, 1H), 2.45 (dtd, *J* = 12.0, 4.4, 3.0 Hz, 1H), 2.39–2.30 (m, 1H), 2.18–2.10 (m, 1H), 2.05–1.92 (m, 2H), 1.90–1.79 (m, 1H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 143.39, 142.83, 130.11, 128.04, 126.80, 126.55, 122.04, 120.42, 117.18, 115.31, 114.23, 109.48, 60.05, 51.87, 47.23, 30.53, 28.42, 24.14, 23.48. HMRS (ESI$^+$) calc. for $C_{19}H_{21}N_2$ $[M+H]^+$ 277.1699, found 277.1699.



16

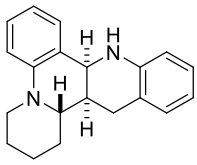
The titled compound (**16**) was obtained as white solid (1.4 mg, 1.0%) using the described general method [from **1** (0.50 mmol) and **13** (0.50 mmol) and the mutant R19/F87A/A328I (0.50 μmol) in phosphate buffer, 100 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (500 MHz, $CDCl_3$) δ 8.81 (d, *J* = 2.3 Hz, 1H), 8.03 (d, *J* = 8.4 Hz, 1H), 7.83 (d, *J* = 2.2 Hz, 1H), 7.66 (d, *J* = 8.1 Hz, 1H), 7.60 (ddd, *J* = 8.4, 6.9, 1.5 Hz, 1H), 7.44 (ddd, *J* = 8.1, 6.8, 1.2 Hz, 1H), 7.08 (dd, *J* = 8.7, 7.3 Hz, 2H), 6.60 (t, *J* = 7.3 Hz, 1H), 6.49–6.44 (m, 2H), 4.87 (d, *J* = 8.4 Hz, 1H), 3.78–3.71 (m, 1H), 3.40 (q, *J* = 8.2 Hz, 1H),

2.48–2.41 (m, 1H), 1.99 (td, *J* = 7.5, 7.0, 5.0 Hz, 3H). HMRS (ESI$^+$) calc. for $C_{19}H_{19}N_2$ $[M+H]^+$ 275.1543, found 275.2.



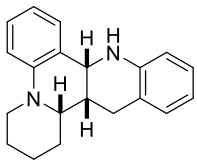
17

The titled compound (**17**) was obtained as white solid (2.1 mg, 1.5%) using the described general method [from **1** (0.50 mmol) and **13** (0.50 mmol) and the mutant R19/F87A/A328I (0.50 μmol) in phosphate buffer, 100 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (400 MHz, $CDOD_3$) δ 7.05 (dt, *J* = 7.5, 1.4 Hz, 1H), 6.87–6.83 (m, 1H), 6.81 (d, *J* = 7.4 Hz, 1H), 6.77–6.69 (m, 2H), 6.53 (dd, *J* = 8.0, 1.2 Hz, 1H), 6.49 (d, *J* = 7.4 Hz, 1H), 6.41 (td, *J* = 7.4, 1.2 Hz, 1H), 6.38–6.33 (m, 2H), 6.30 (td, *J* = 7.4, 1.2 Hz, 1H), 6.23 (d, *J* = 7.8 Hz, 1H), 4.44 (d, *J* = 4.2 Hz, 1H), 3.76 (dd, *J* = 9.7, 3.1 Hz, 1H), 3.38 (dd, *J* = 9.9, 8.0 Hz, 1H), 3.30 (td, *J* = 6.7, 3.8 Hz, 1H), 3.05 (td, *J* = 9.4, 7.0 Hz, 1H), 2.71 (dt, *J* = 13.0, 6.7 Hz, 2H), 2.52 (dq, *J* = 12.8, 4.4 Hz, 1H), 2.34–2.27 (m, 1H), 2.23 (dd, *J* = 16.2, 5.4 Hz, 1H), 2.19–2.10 (m, 1H), 2.01 (dd, *J* = 16.1, 12.5 Hz, 1H), 1.86 (p, *J* = 6.2 Hz, 2H), 1.79–1.69 (m, 1H). HMRS (ESI$^+$) calc. for $C_{28}H_{30}N_3$ $[M+H]^+$ 408.2434, found 408.2437.



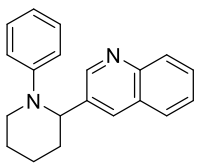
18

The titled compound (**18**) was obtained as white solid (8.0 mg, 5%) using the described general method [from **7** (0.50 mmol) and **13** (0.50 mmol) and the mutant R19/F87A/A328I (0.50 μmol) in phosphate buffer, 100 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (400 MHz, C_6D_6) δ 7.20 (d, *J* = 7.0 Hz, 1H), 7.06–7.00 (m, 2H), 6.88 (d, *J* = 7.5 Hz, 1H), 6.76 (t, *J* = 7.4 Hz, 1H), 6.69 (dt, *J* = 7.5, 3.3 Hz, 2H), 6.26 (d, *J* = 8.0 Hz, 1H), 4.06 (t, *J* = 3.1 Hz, 1H), 3.60 (dt, *J* = 12.5, 3.5 Hz, 1H), 3.49 (s, 1H), 2.63 (ddd, *J* = 11.3, 7.2, 2.2 Hz, 1H), 2.51 (dd, *J* = 16.4, 5.3 Hz, 1H), 2.44–2.33 (m, 2H), 1.83 (p, *J* = 6.1 Hz, 1H), 1.59–1.50 (m, 2H), 1.37 (dq, *J* = 7.9, 4.0 Hz, 2H), 1.25–1.13 (m, 1H), 1.00 (tdt, *J* = 12.5, 8.4, 3.9 Hz, 1H). ^{13}C NMR (101 MHz, C_6D_6) δ 146.23, 143.24, 128.82, 127.94, 127.54, 118.96, 117.56, 117.20, 116.09, 113.89, 112.92, 57.84, 51.27, 48.15, 37.45, 32.39, 30.15, 26.15, 24.89. HMRS (ESI$^+$) calc. for $C_{20}H_{23}N_2$ $[M+H]^+$ 291.1856, found 291.2.



19

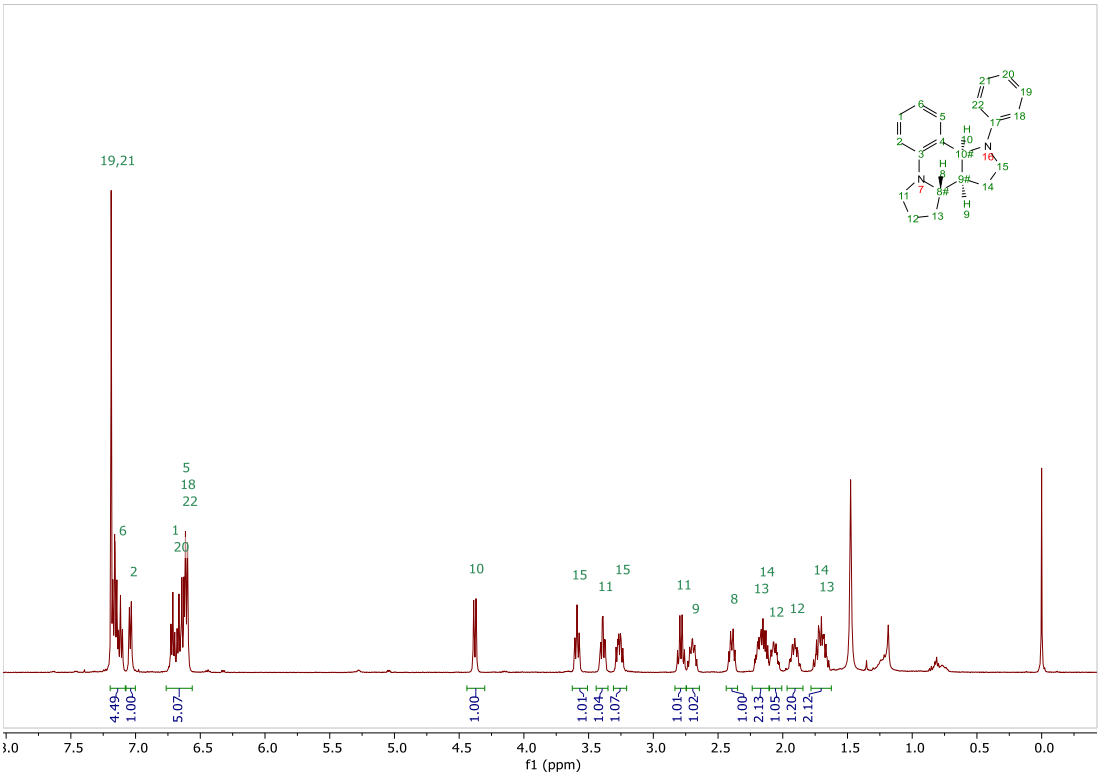
The titled compound (**19**) was obtained as white solid (10.6 mg, 7%) using the described general method [from **7** (0.50 mmol) and **13** (0.50 mmol) and the mutant R19/F87A/A328I (0.50 μmol) in phosphate buffer, 100 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (400 MHz, C_6D_6) δ 7.12 (dt, *J* = 7.5, 1.3 Hz, 1H), 7.06 (q, *J* = 8.6, 8.1 Hz, 2H), 6.85 (d, *J* = 7.4 Hz, 1H), 6.69 (dq, *J* = 14.7, 7.4 Hz, 3H), 6.43 (d, *J* = 8.0 Hz, 1H), 4.19–4.13 (m, 1H), 3.87 (s, 1H), 3.78–3.68 (m, 1H), 2.84 (dt, *J* = 11.6, 2.8 Hz, 1H), 2.71 (dd, *J* = 16.3, 11.5 Hz, 1H), 2.52 (dd, *J* = 16.4, 5.4 Hz, 1H), 2.46 – 2.32 (m, 1H), 1.97 (dtd, *J* = 12.0, 4.9, 3.1 Hz, 1H), 1.56 (dt, *J* = 12.7, 3.4 Hz, 1H), 1.47–1.29 (m, 2H), 1.25 – 1.15 (m, 1H), 1.06 (dd, *J* = 10.9, 5.8 Hz, 1H). ^{13}C NMR (101 MHz, C_6D_6) δ 145.93, 143.24, 130.13, 128.19, 127.94, 127.03, 126.34, 120.74, 118.29, 117.30, 114.21, 113.82, 60.43, 51.70, 48.90, 35.54, 29.70, 26.24, 24.93, 24.59. HMRS (ESI$^+$) calc. for $C_{20}H_{23}N_2$ $[M+H]^+$ 291.1856, found 291.2.



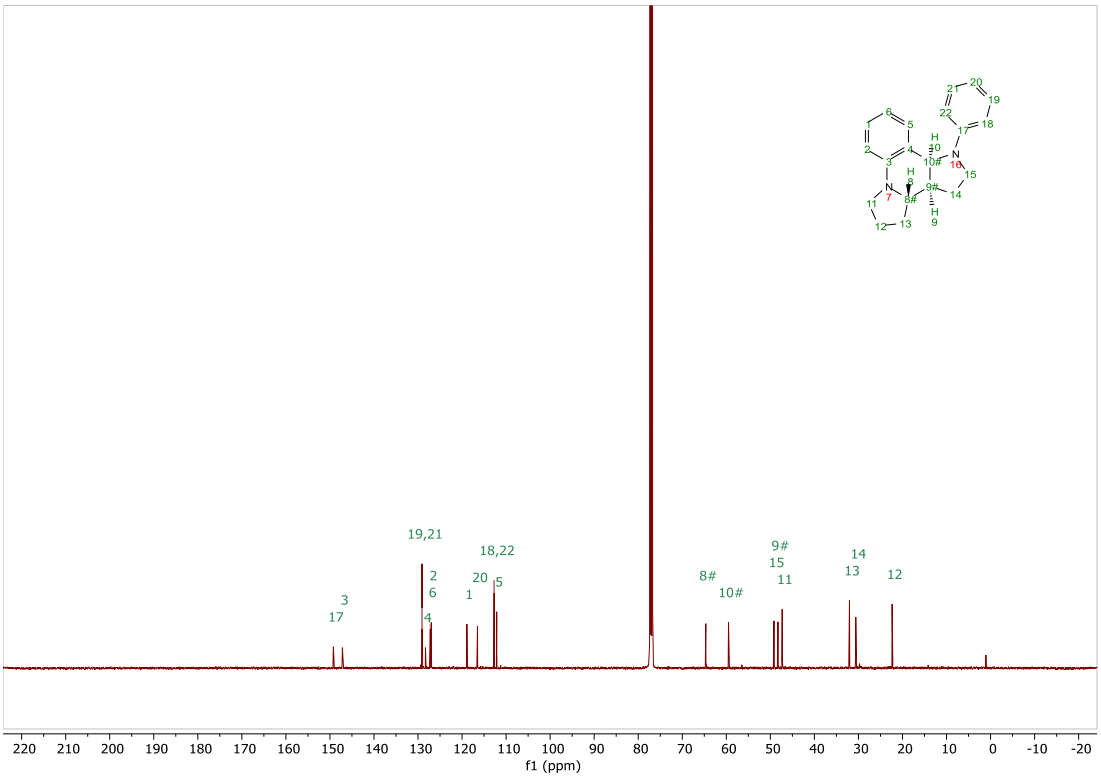
20

The titled compound (**20**) was obtained as white solid (0.3 mg, 0.2%) using the described general method [from **7** (0.50 mmol) and **13** (0.50 mmol) and the mutant R19/F87A/A328I (0.50 μmol) in phosphate buffer, 100 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (500 MHz, $CDCl_3$) δ 8.88 (s, 1H), 8.01 (d, *J* = 8.7 Hz, 1H), 7.96 (s, 1H), 7.69 (d, *J* = 8.0 Hz, 1H), 7.62 (t, *J* = 7.9 Hz, 1H), 7.50–7.45 (m, 1H), 7.12 (t, *J* =

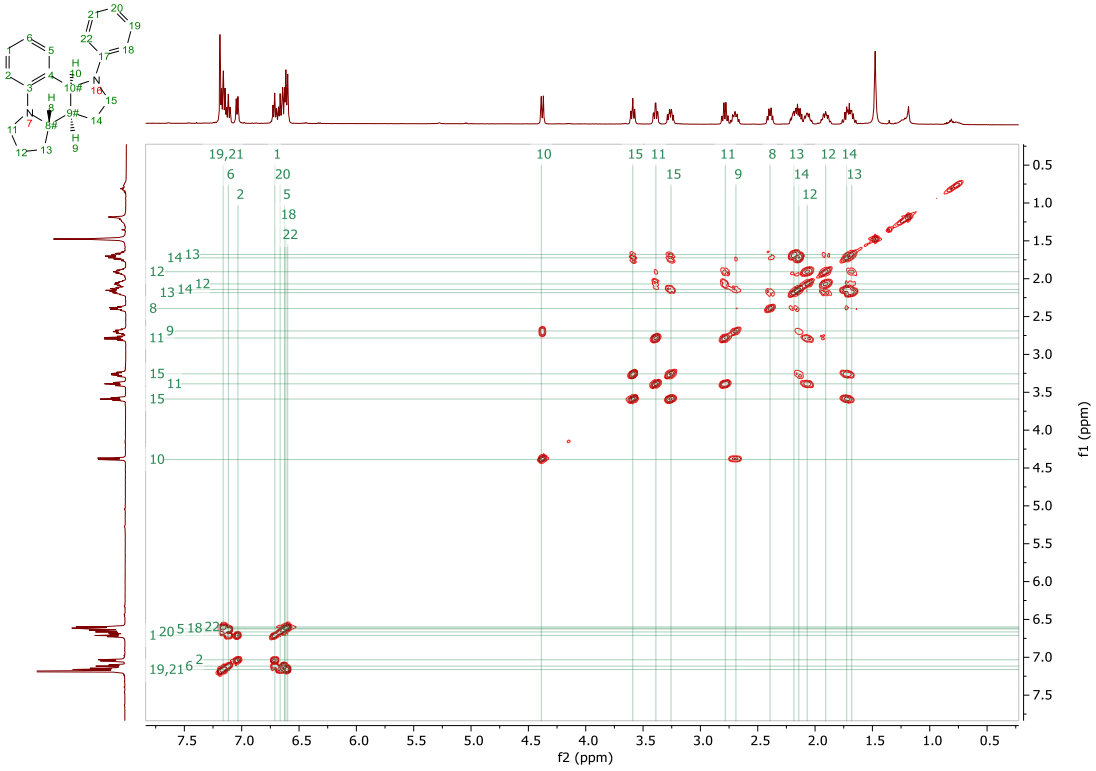
7.8 Hz, 2H), 6.97 (d, *J* = 8.0 Hz, 2H), 6.78 (t, *J* = 7.3 Hz, 1H), 4.60 (s, 1H), 3.47 (d, *J* = 13.7 Hz, 1H), 3.20 (d, *J* = 8.3 Hz, 1H), 2.08–1.73 (m, 6H). HMRS (ESI$^+$) calc. for $C_{20}H_{21}N_2$ $[M+H]^+$ 289.1699, found 289.1696.



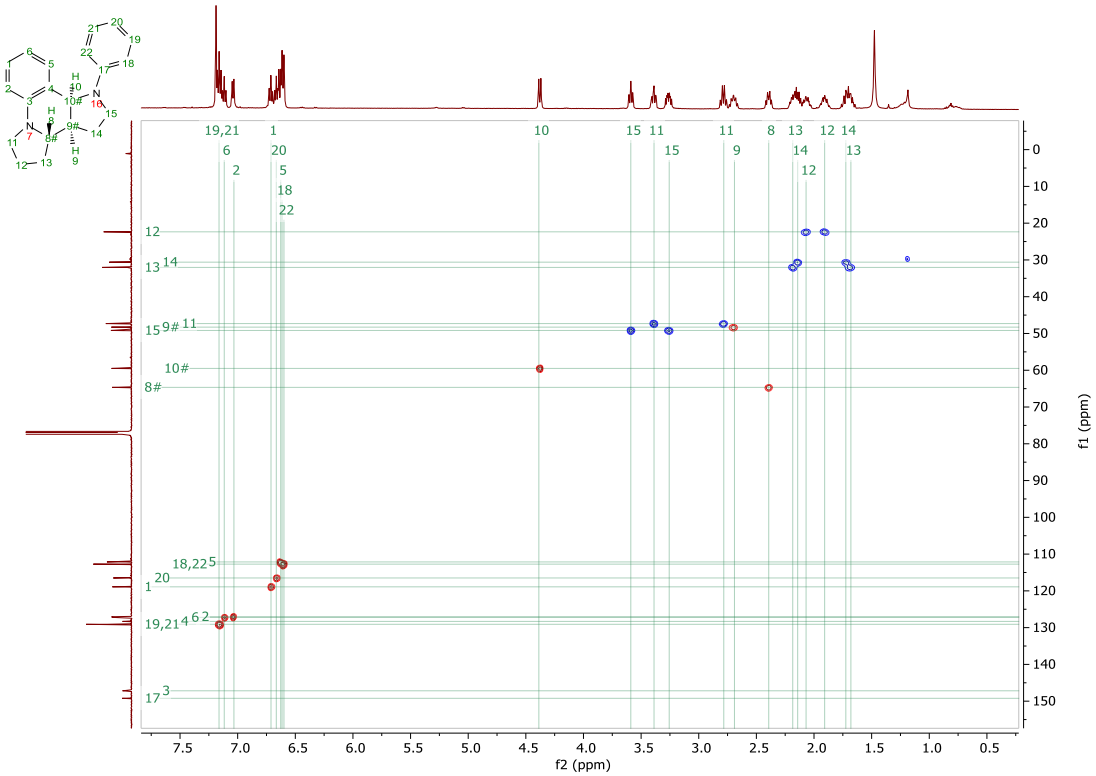
Spectrum 1 The ^{1}H NMR of **5**.



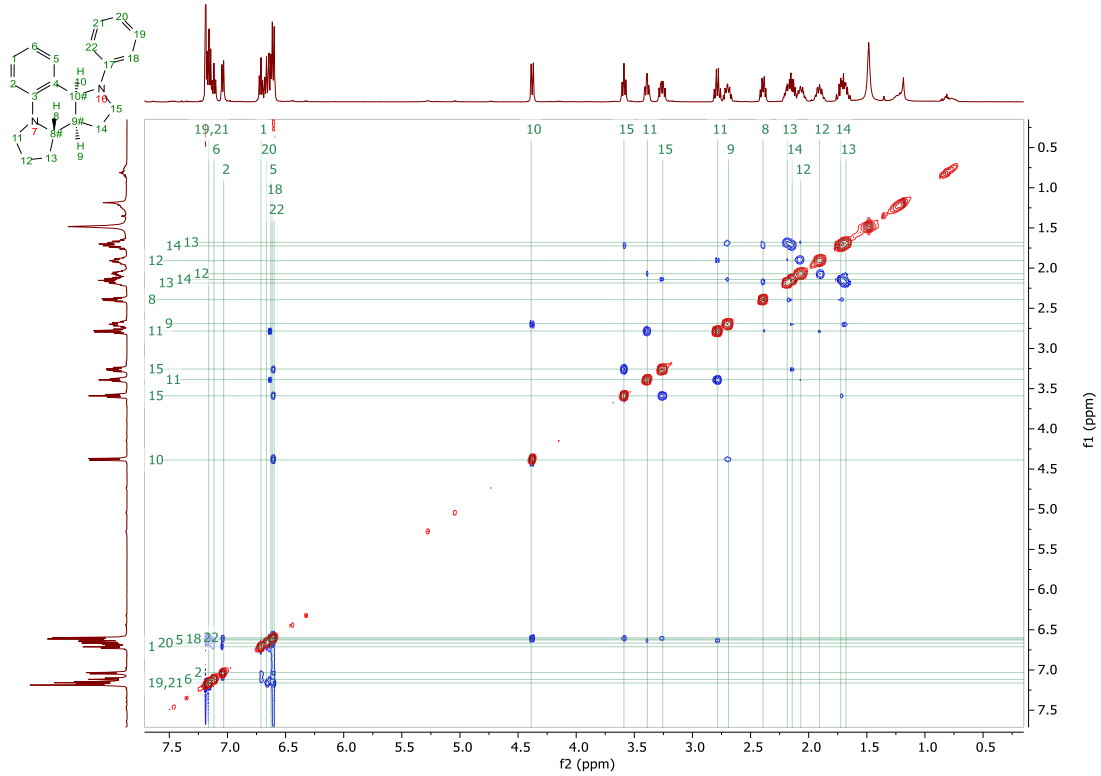
Spectrum 2 The ^{13}C NMR of **5**.



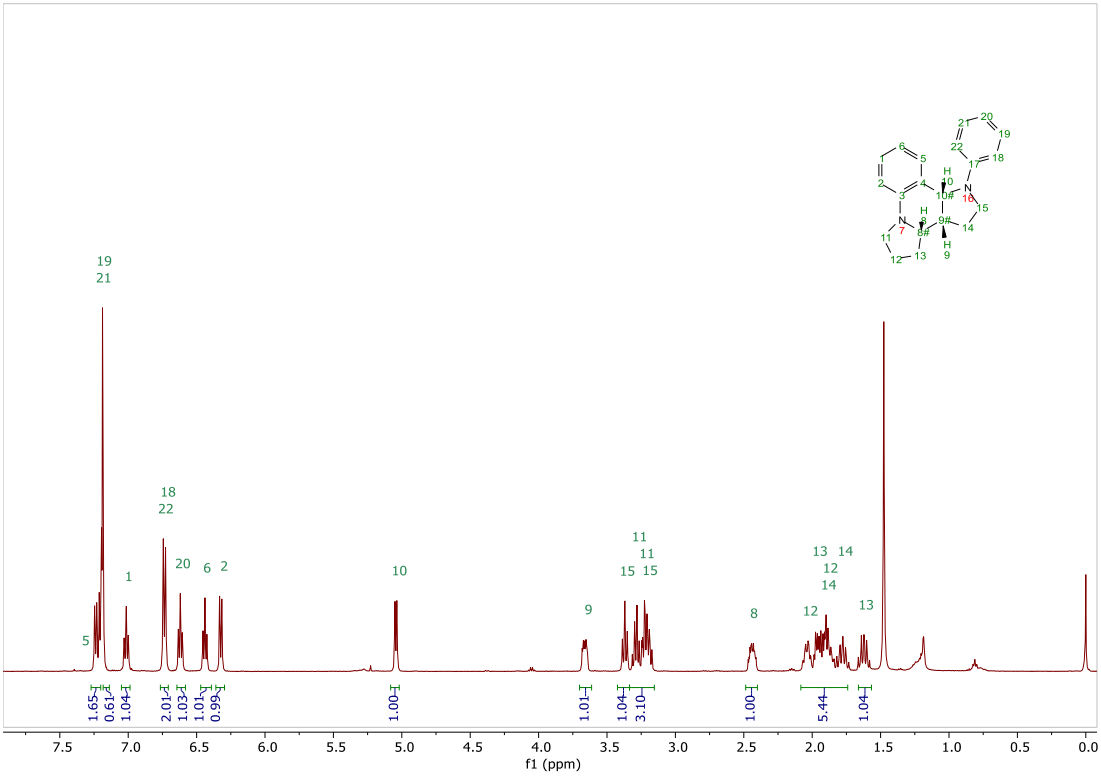
Spectrum 3 The COSY NMR of **5**.



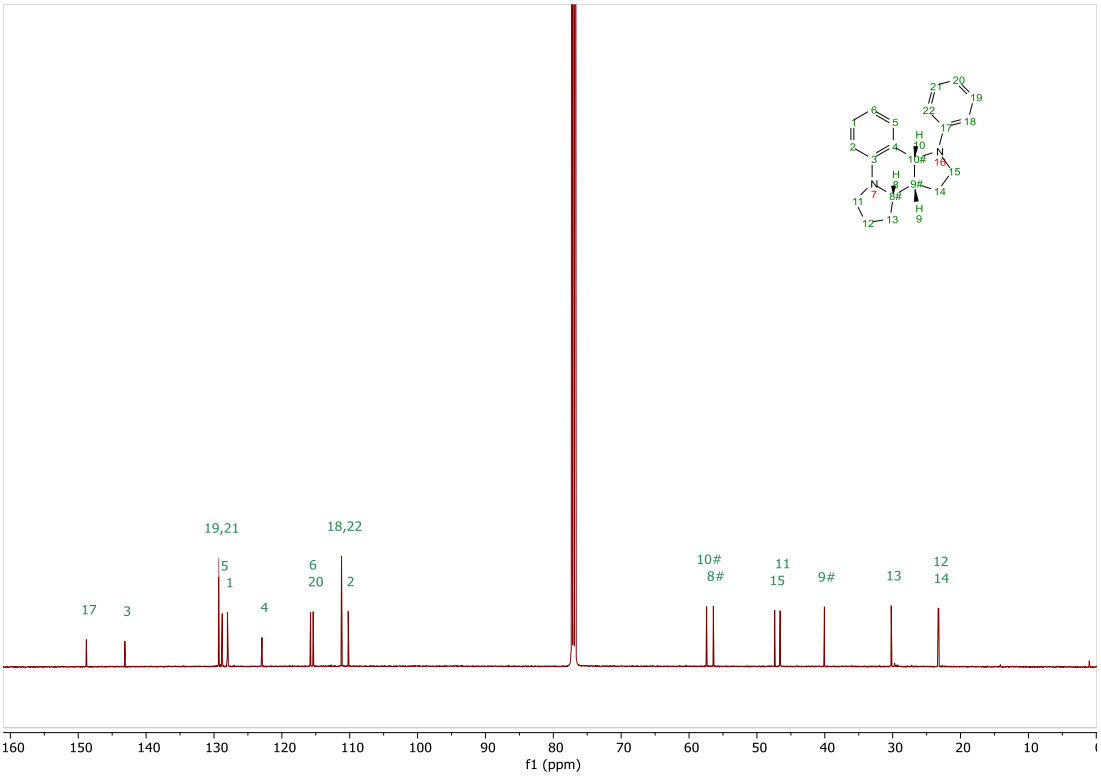
Spectrum 4 The HSQC NMR of **5**.



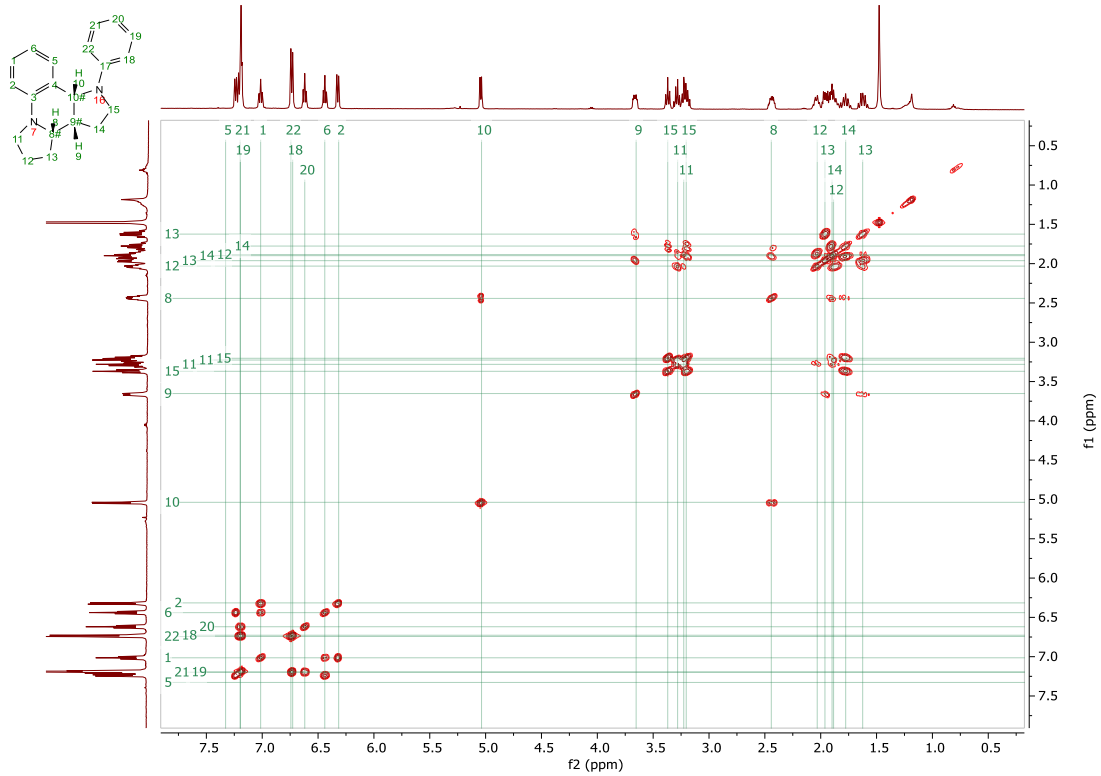
Spectrum 5 The NOESY NMR of **5**.



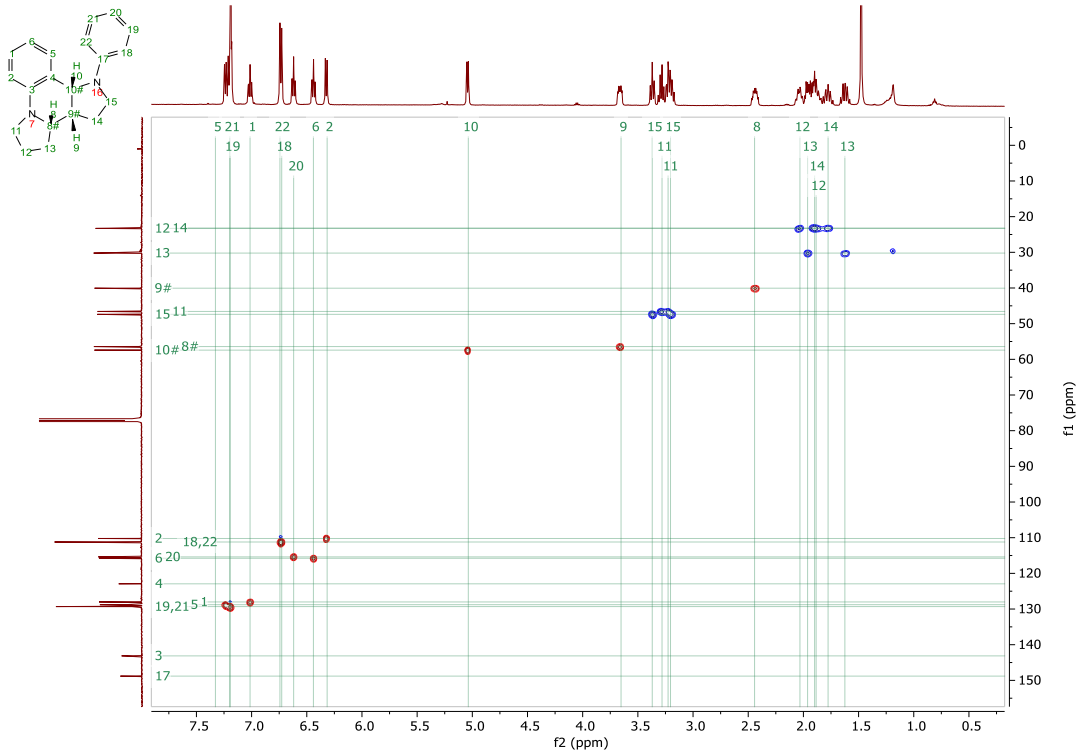
Spectrum 6 The ^{1}H NMR of **6**.



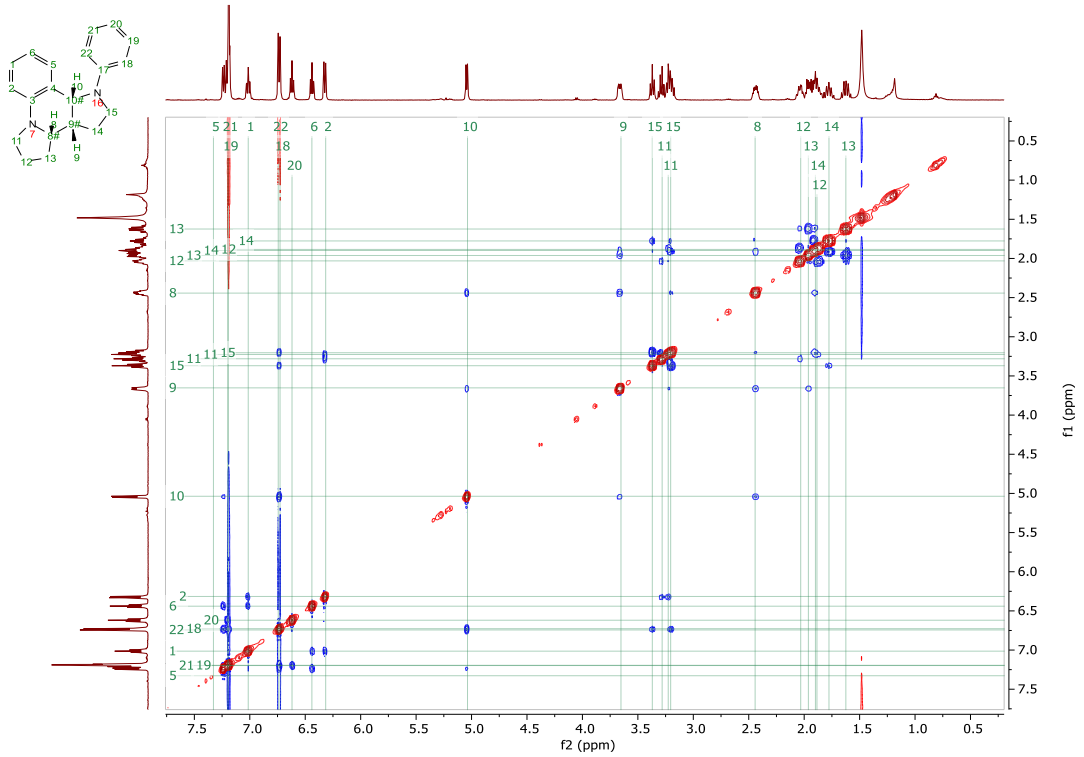
Spectrum 7 The ^{13}C NMR of **6**.



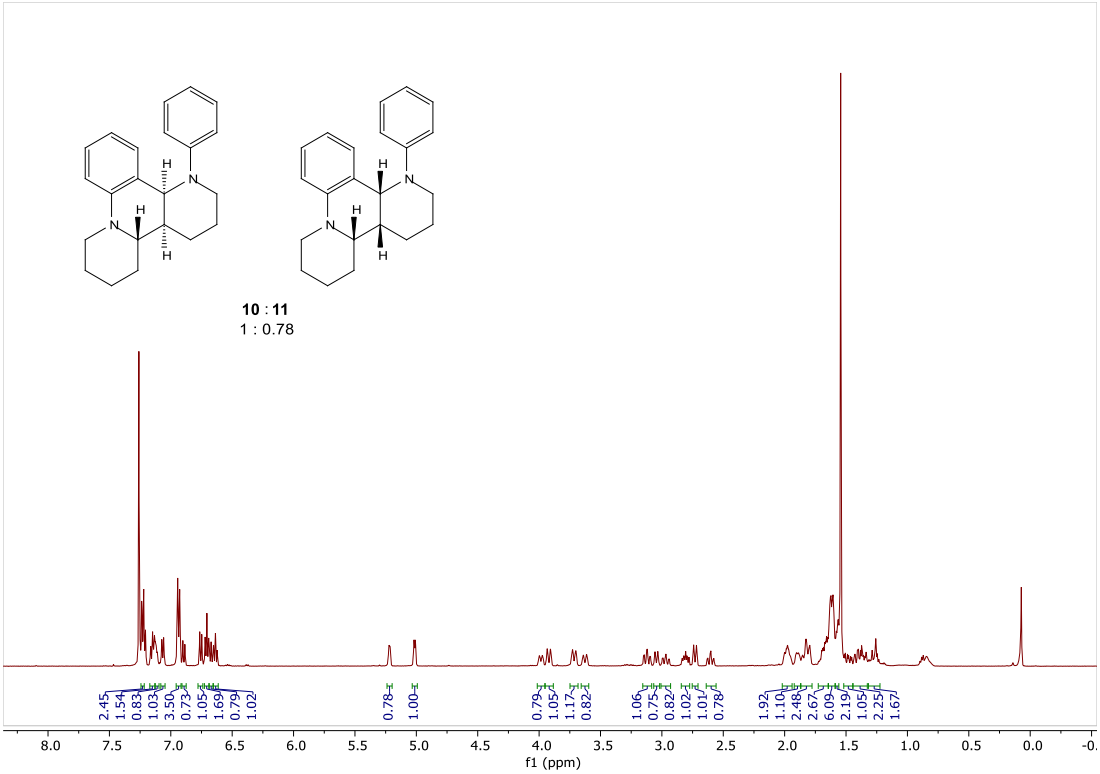
Spectrum 8 The COSY NMR of **6**.



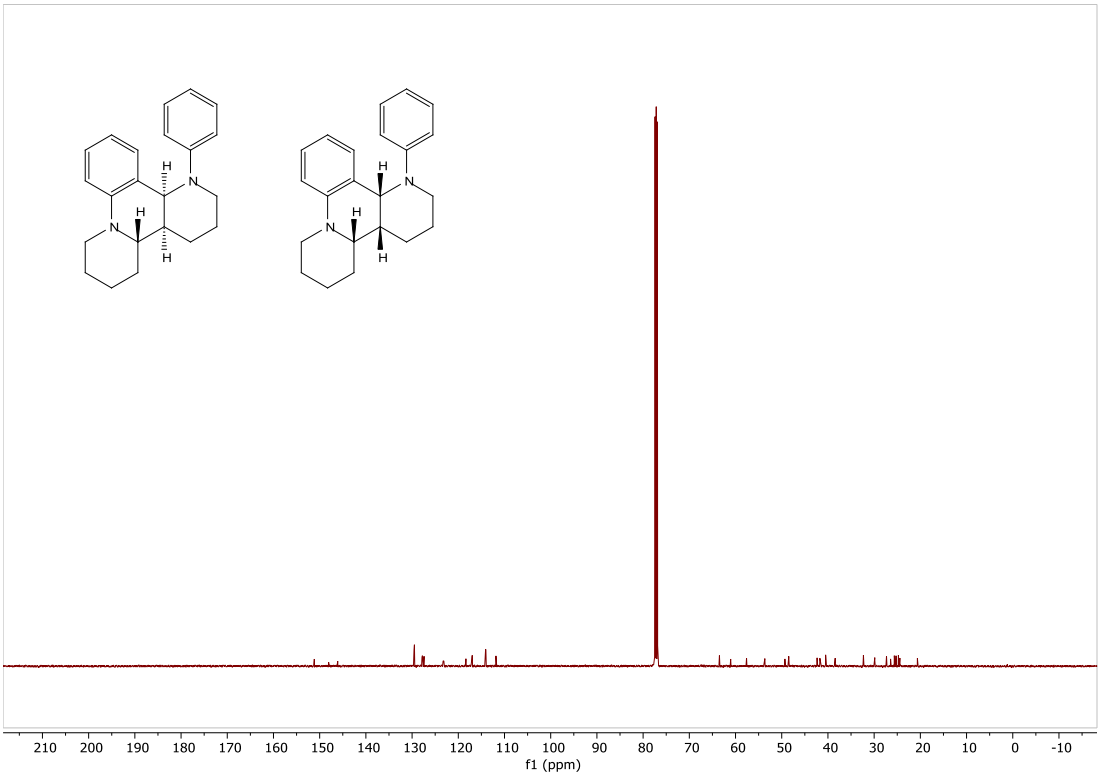
Spectrum 9 The HSQC NMR of **6**.



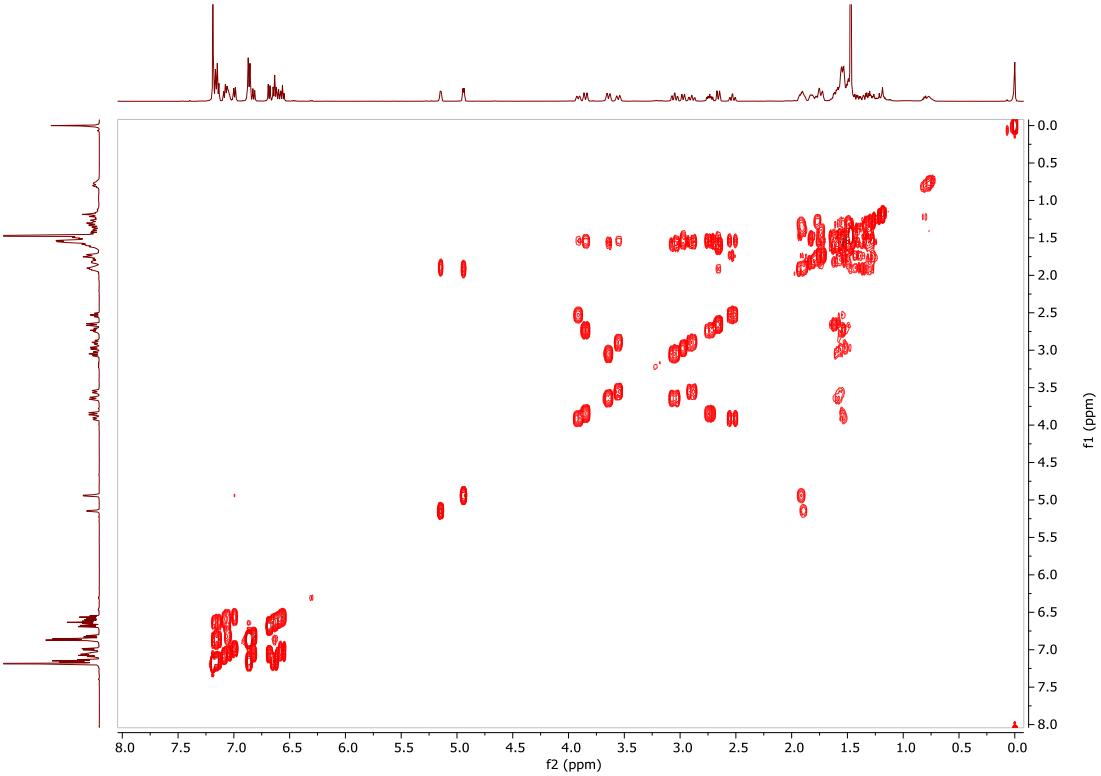
Spectrum 10 The NOESY NMR of **6**.



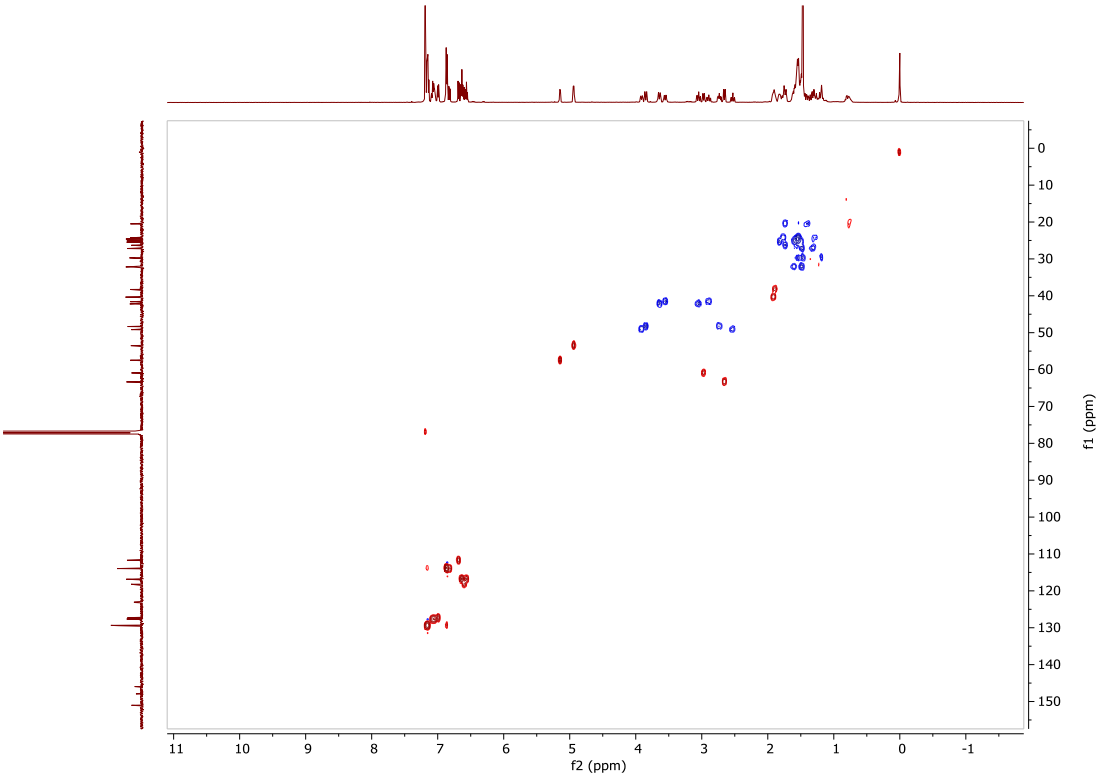
Spectrum 11 The ^{1}H NMR of a mixture of **10** and **11**.



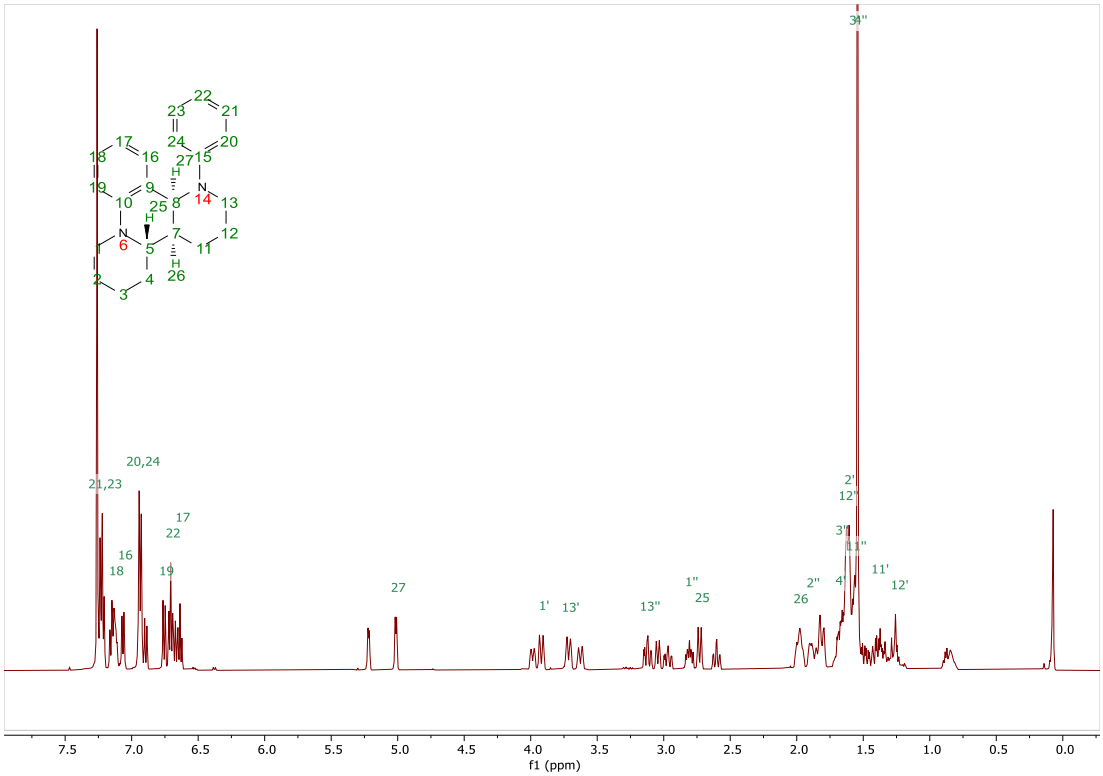
Spectrum 12 The ^{13}C NMR of a mixture of **10** and **11**.



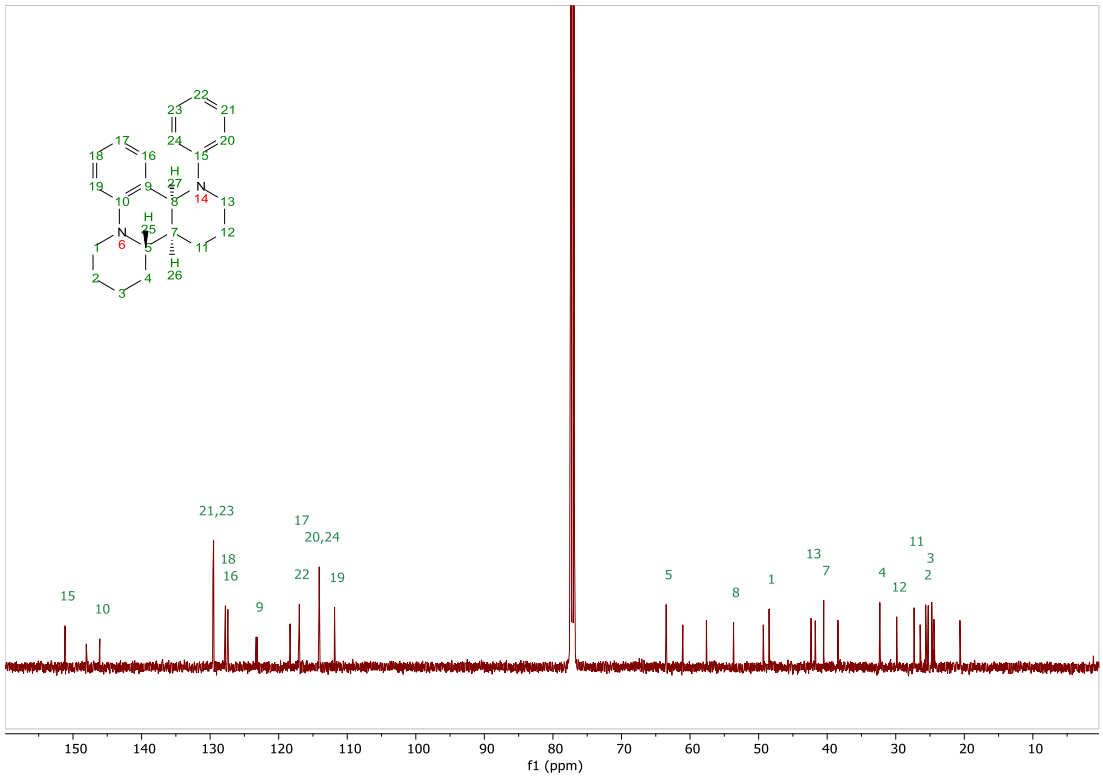
Spectrum 13 The COSY NMR of a mixture of **10** and **11**.



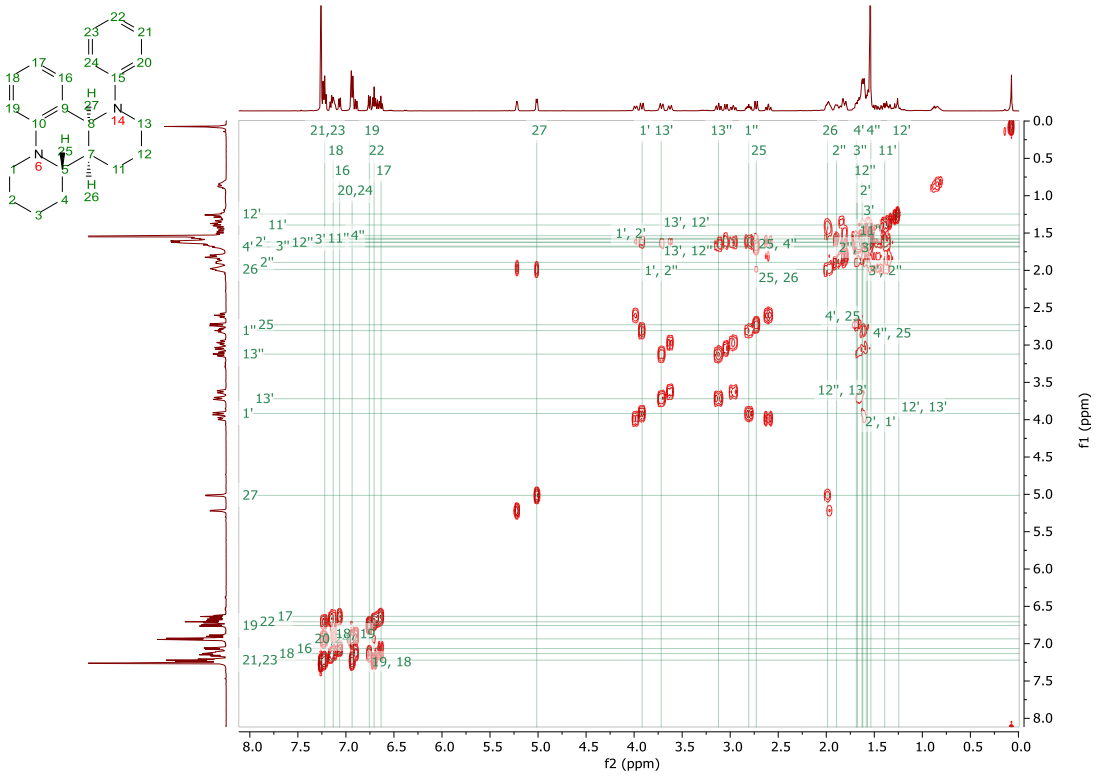
Spectrum 14 The HSQC NMR of a mixture of **10** and **11**.



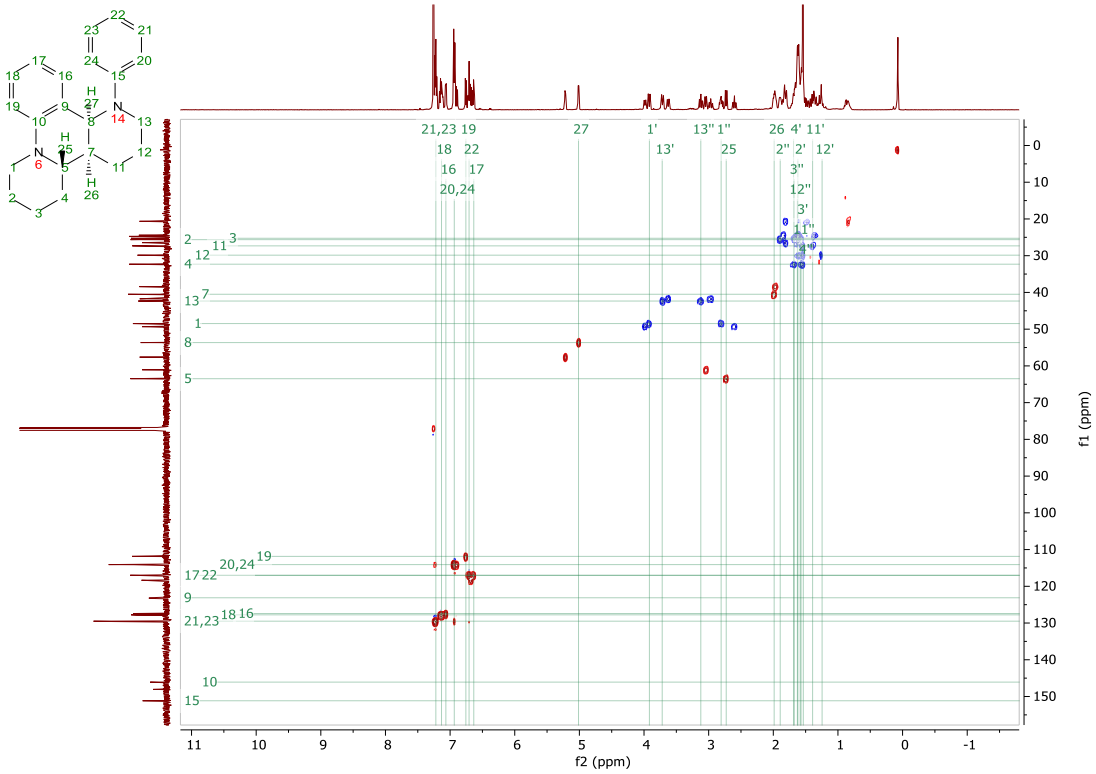
Spectrum 15 The ^{1}H NMR of **10** extracted from the ^{1}H NMR of a mixture of **10** and **11**.



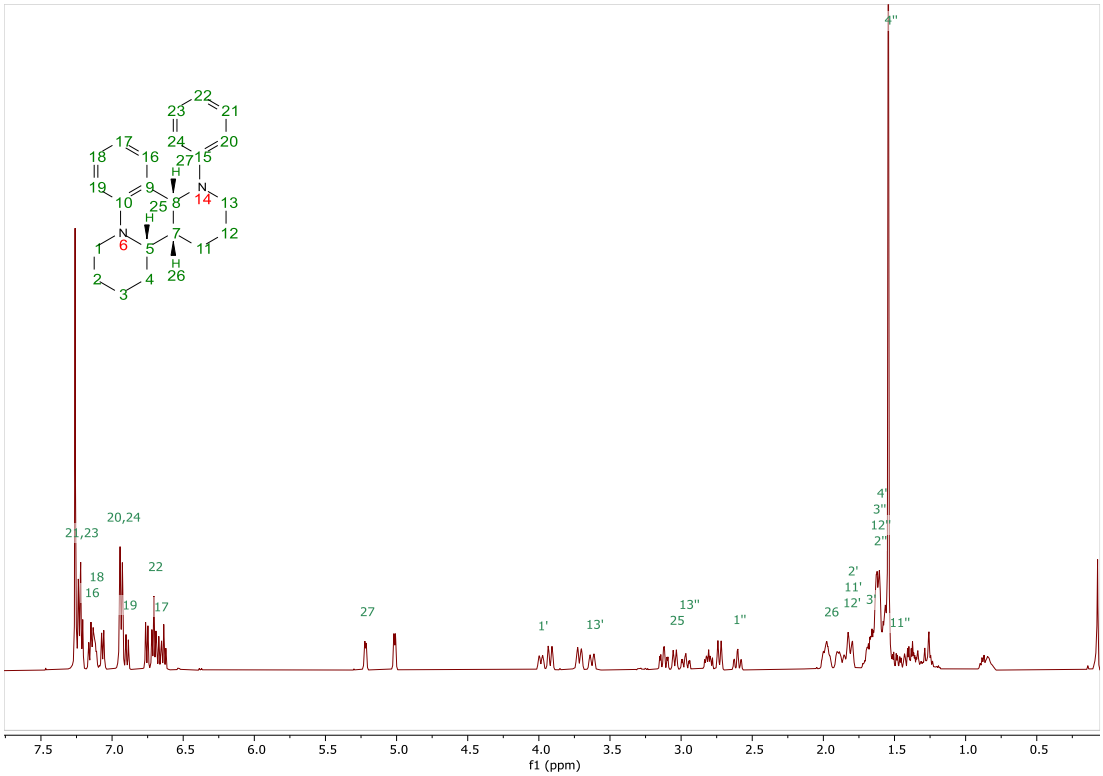
Spectrum 16 The ^{13}C NMR of a mixture of **10** and **11** with tentative assignment of **10** shown.



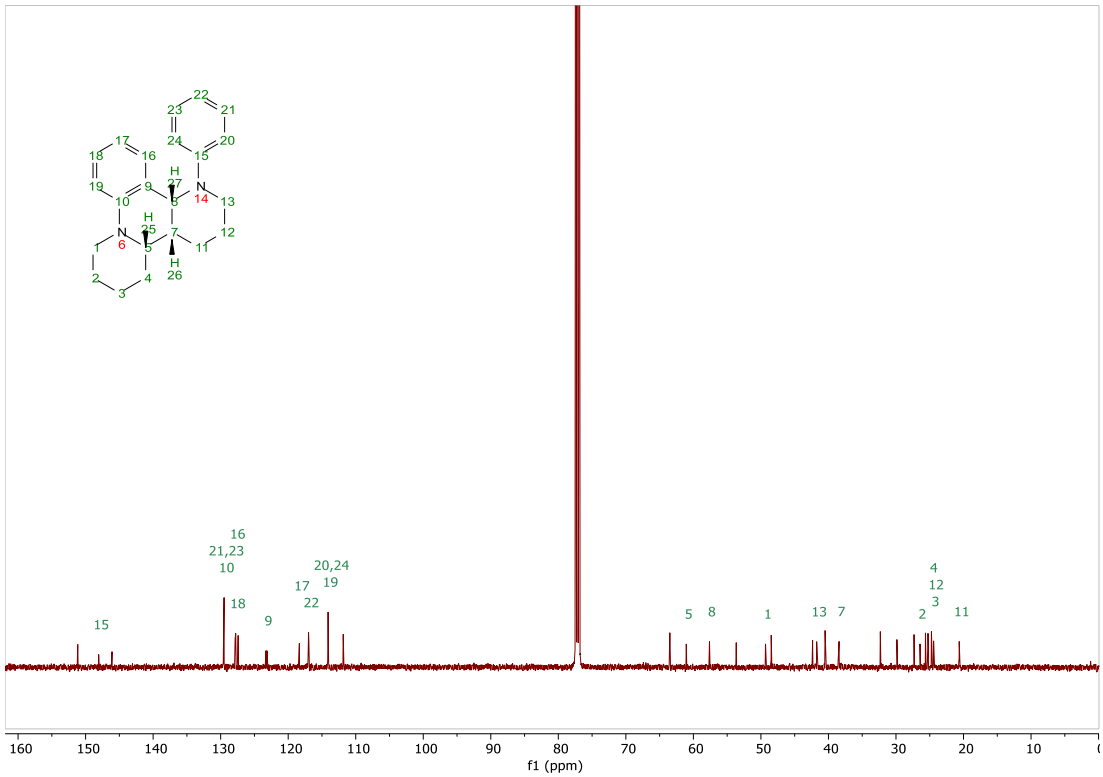
Spectrum 17 The COSY NMR of a mixture of **10** and **11** with tentative assignment of **10** shown.



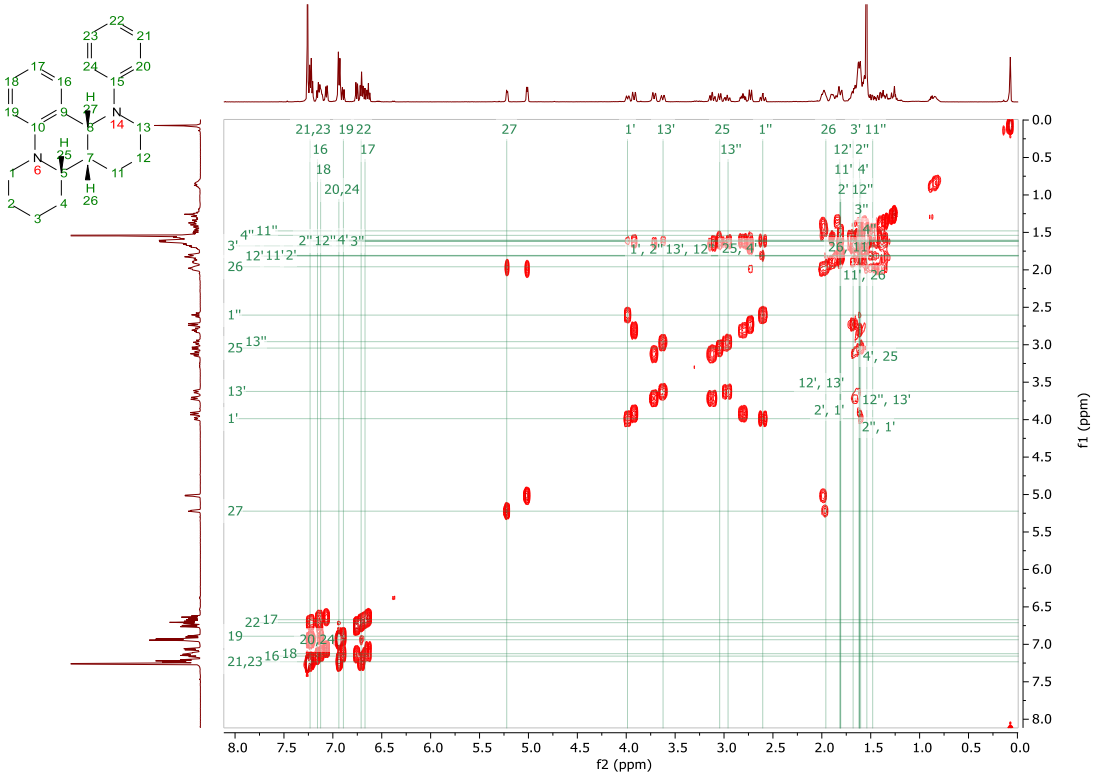
Spectrum 18 The HSQC NMR of a mixture of **10** and **11** with tentative assignment of **10** shown.



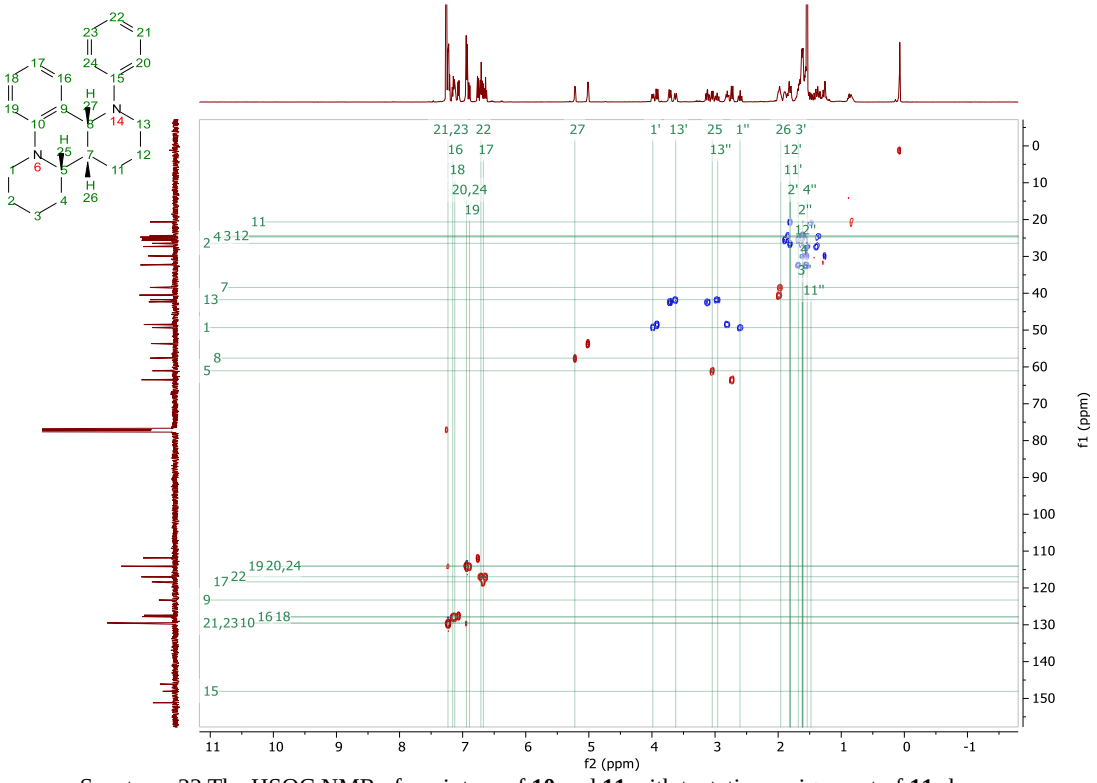
Spectrum 19 The ^{1}H NMR of **11** extracted from the ^{1}H NMR of a mixture of **10** and **11**.



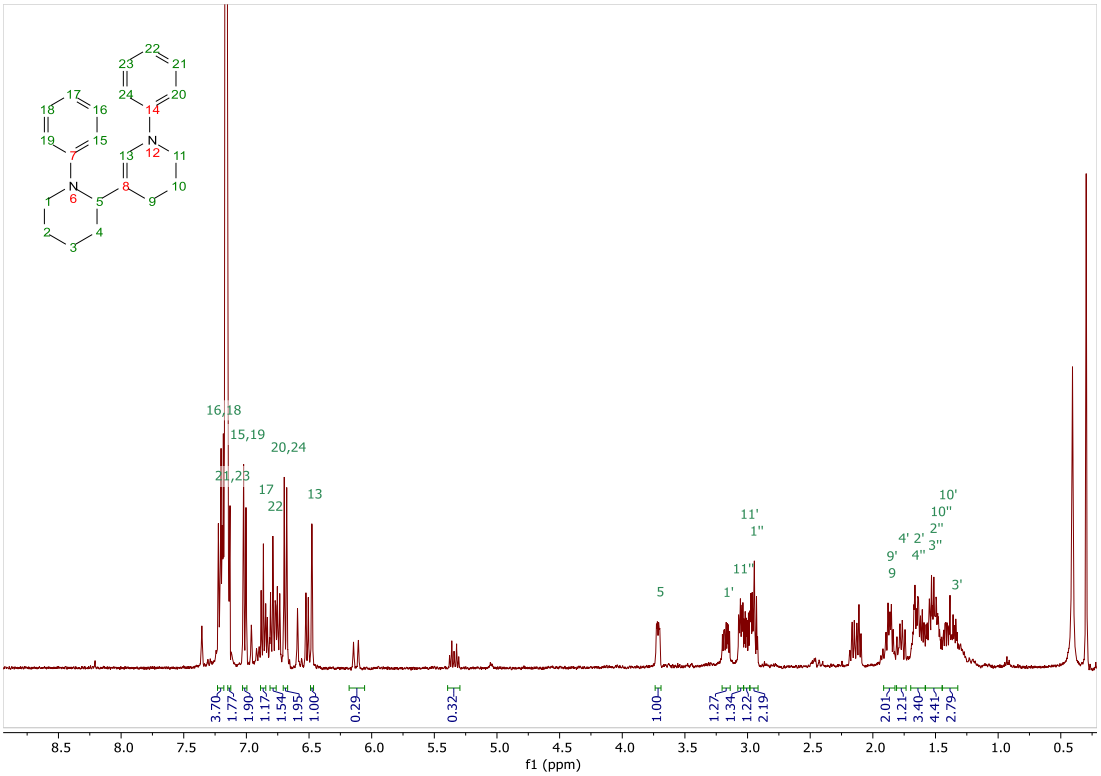
Spectrum 20 The ^{13}C NMR of a mixture of **10** and **11** with tentative assignment of **11** shown.



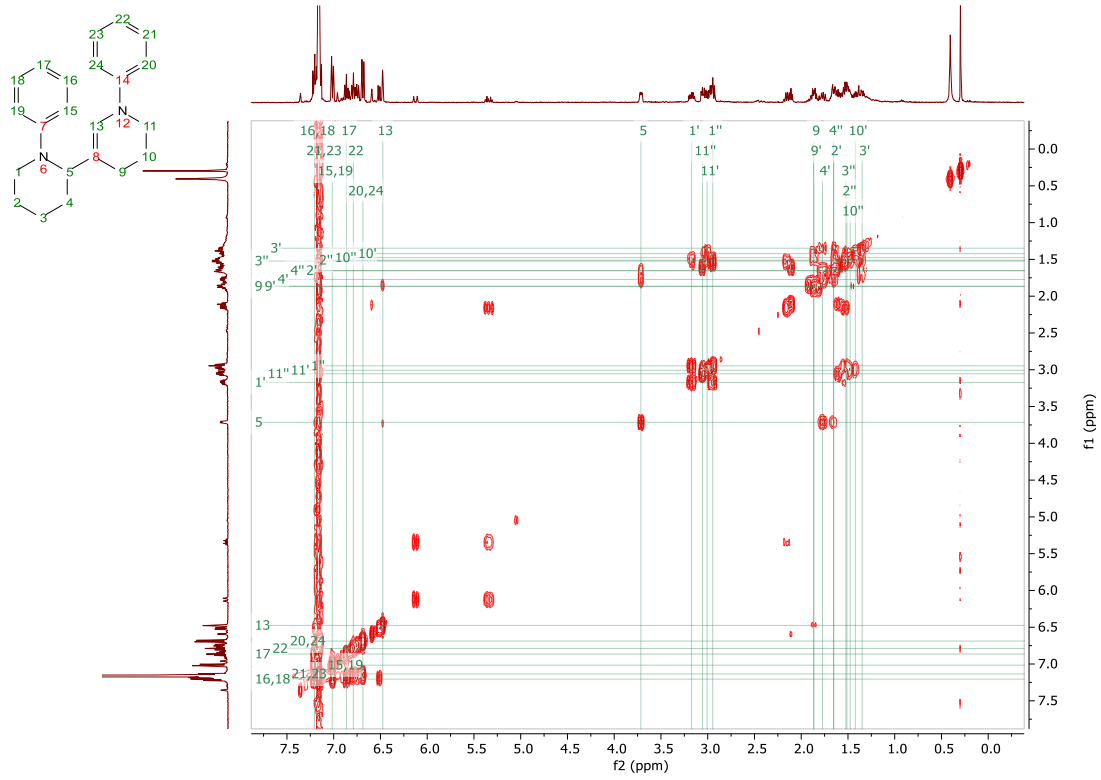
Spectrum 21 The COSY NMR of a mixture of **10** and **11** with tentative assignment of **11** shown.



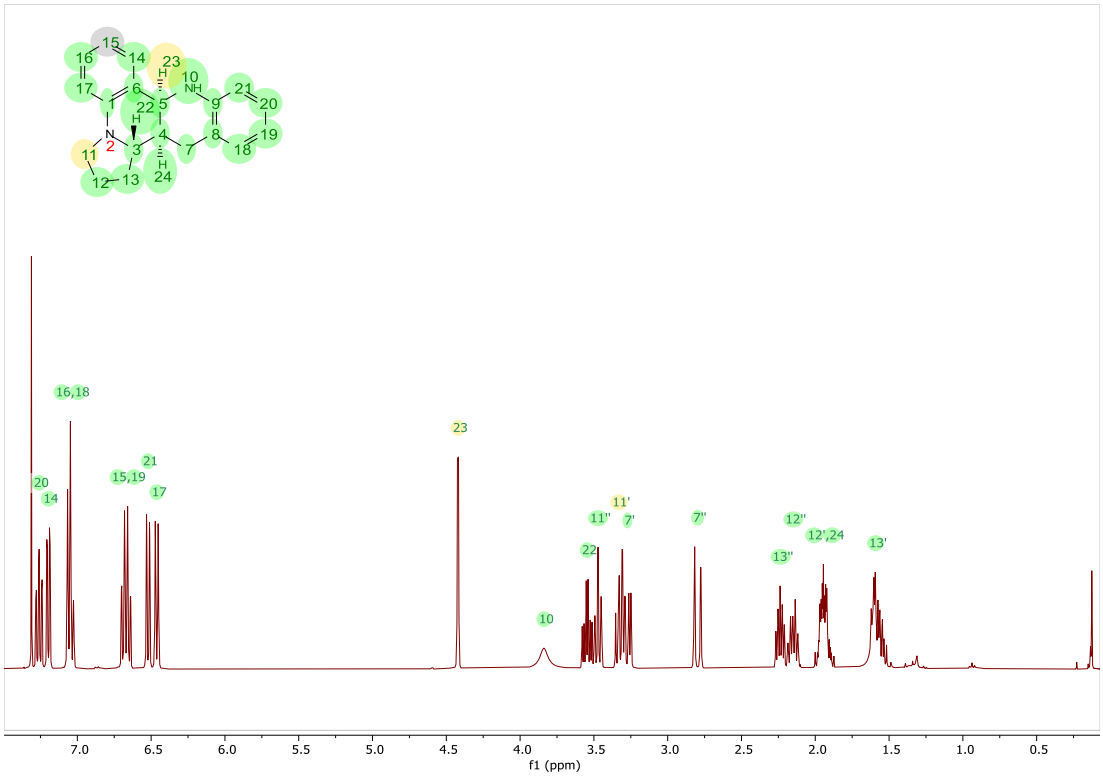
Spectrum 22 The HSQC NMR of a mixture of **10** and **11** with tentative assignment of **11** shown.



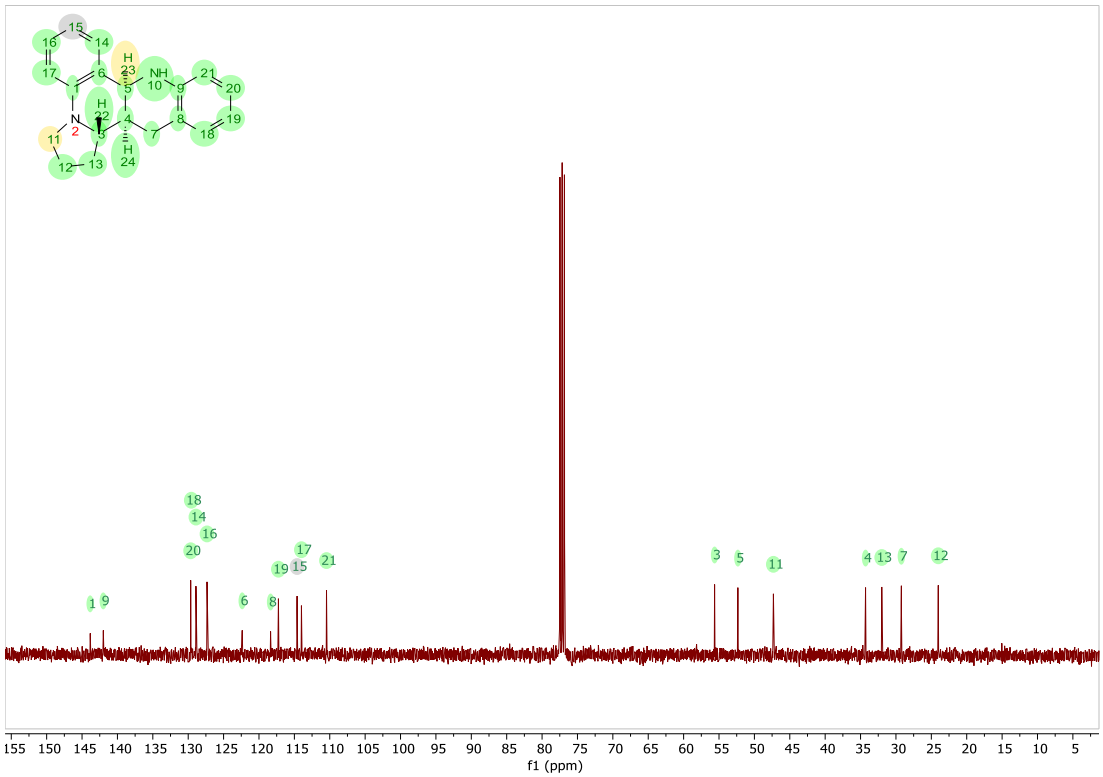
Spectrum 23 The ^{1}H NMR of **12** containing the impurity of the enamine of **7**.



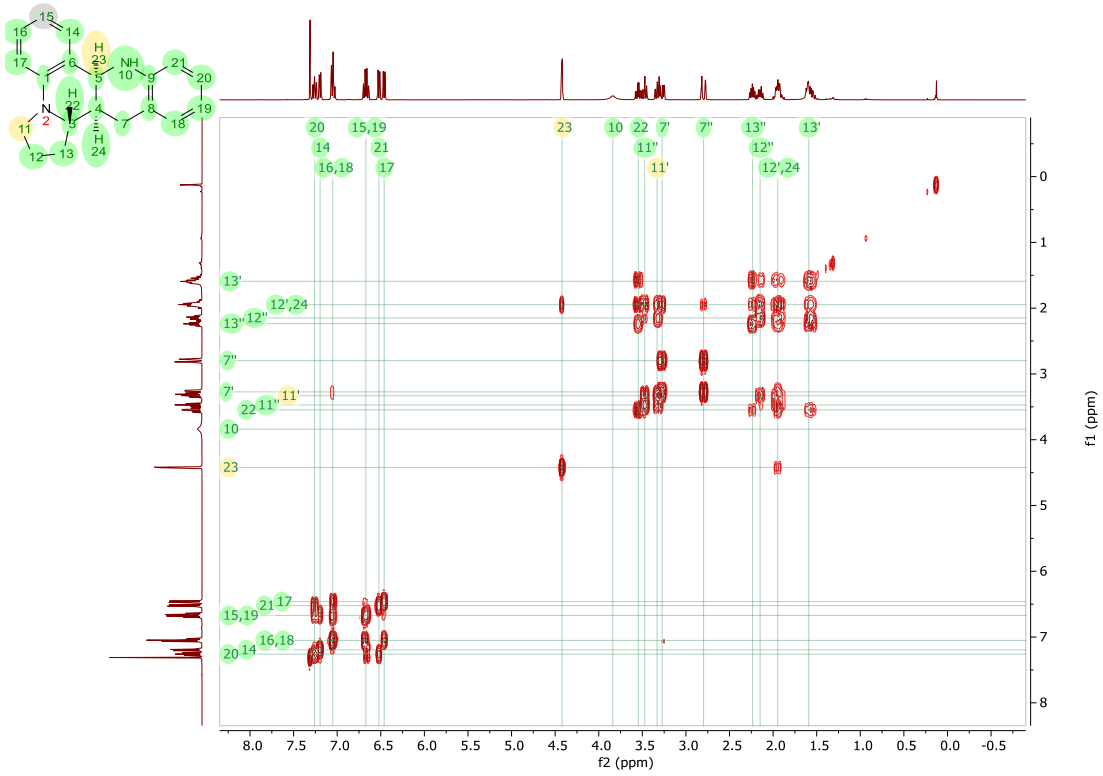
Spectrum 24 The COSY NMR of **12** containing the impurity of the enamine of **7**.



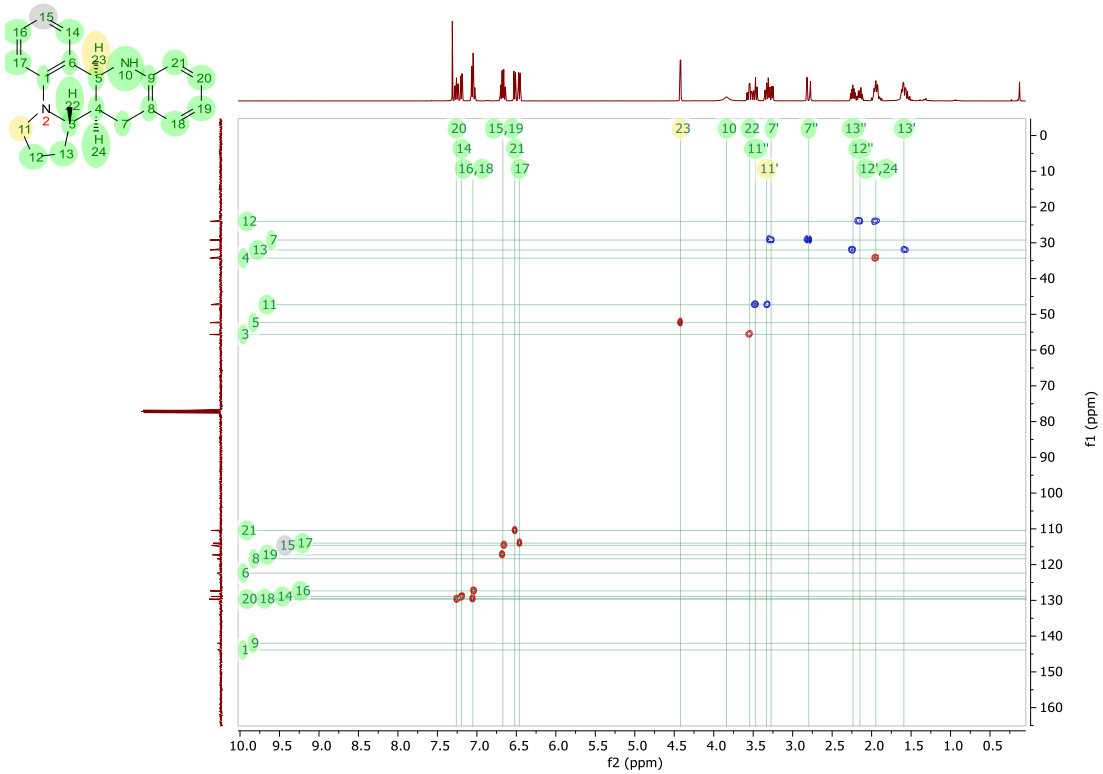
Spectrum 25 The ^{1}H NMR of **14**.



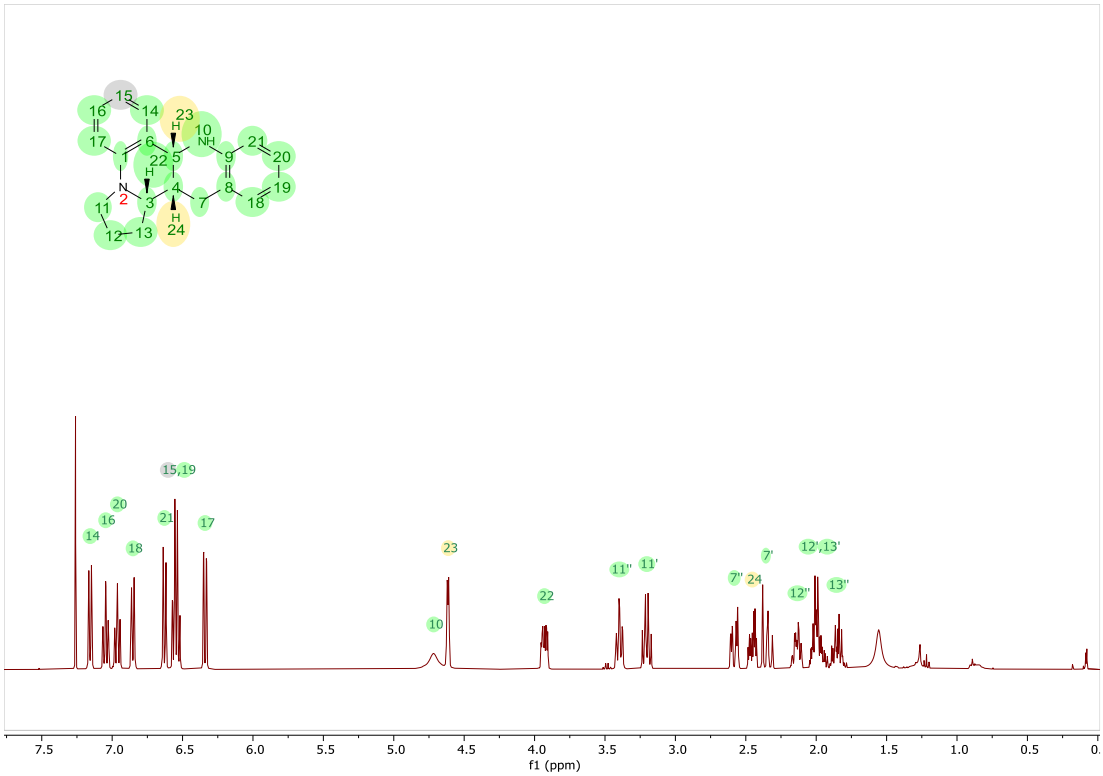
Spectrum 26 The ^{13}C NMR of **14**.



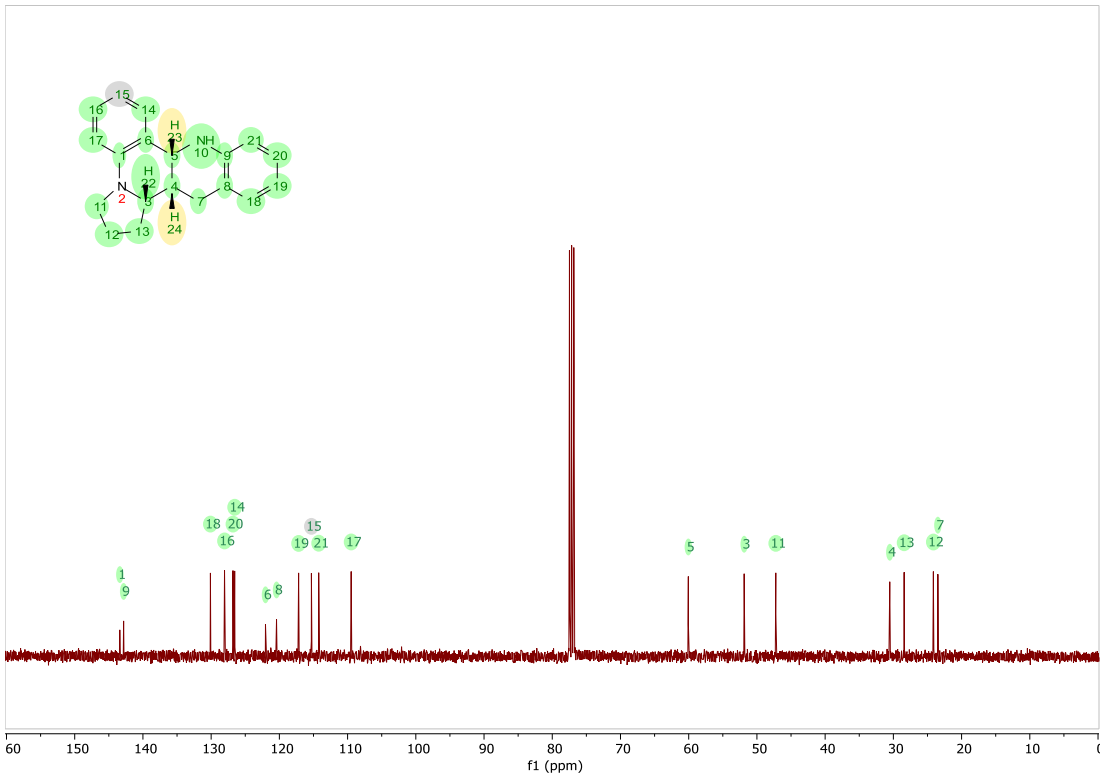
Spectrum 27 The COSY NMR of **14**.



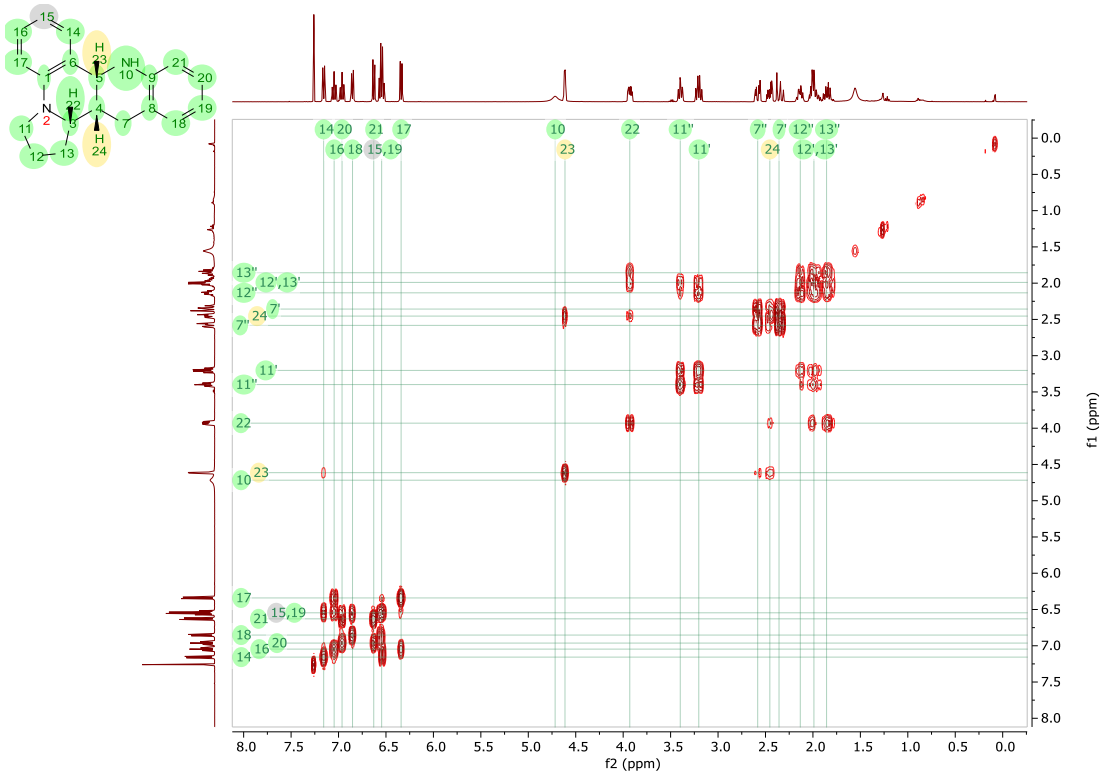
Spectrum 28 The HSQC NMR of **14**.



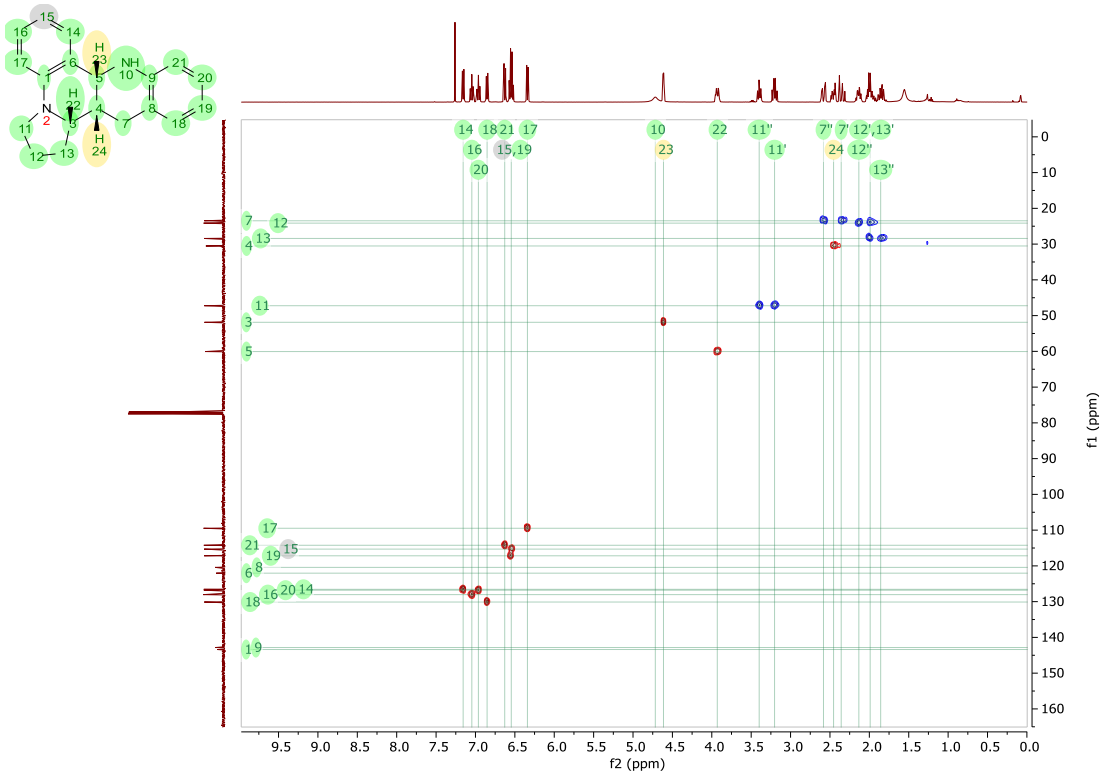
Spectrum 29 The ^{1}H NMR of **15**.



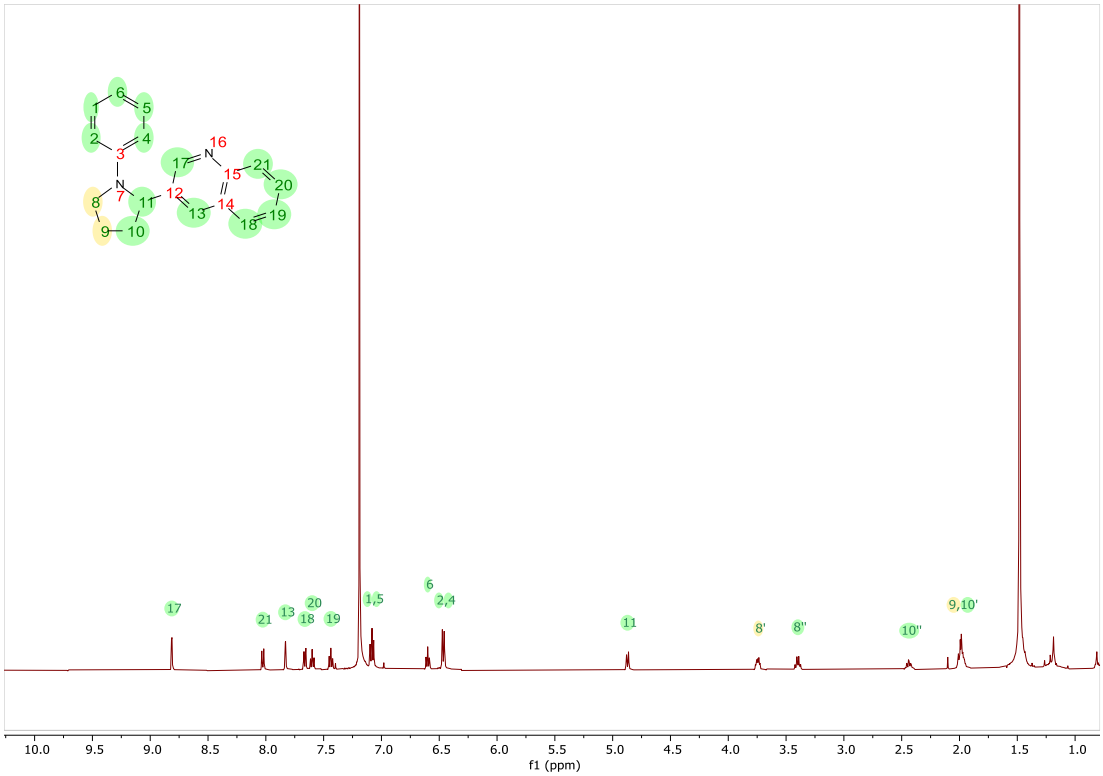
Spectrum 30 The ^{13}C NMR of **15**.



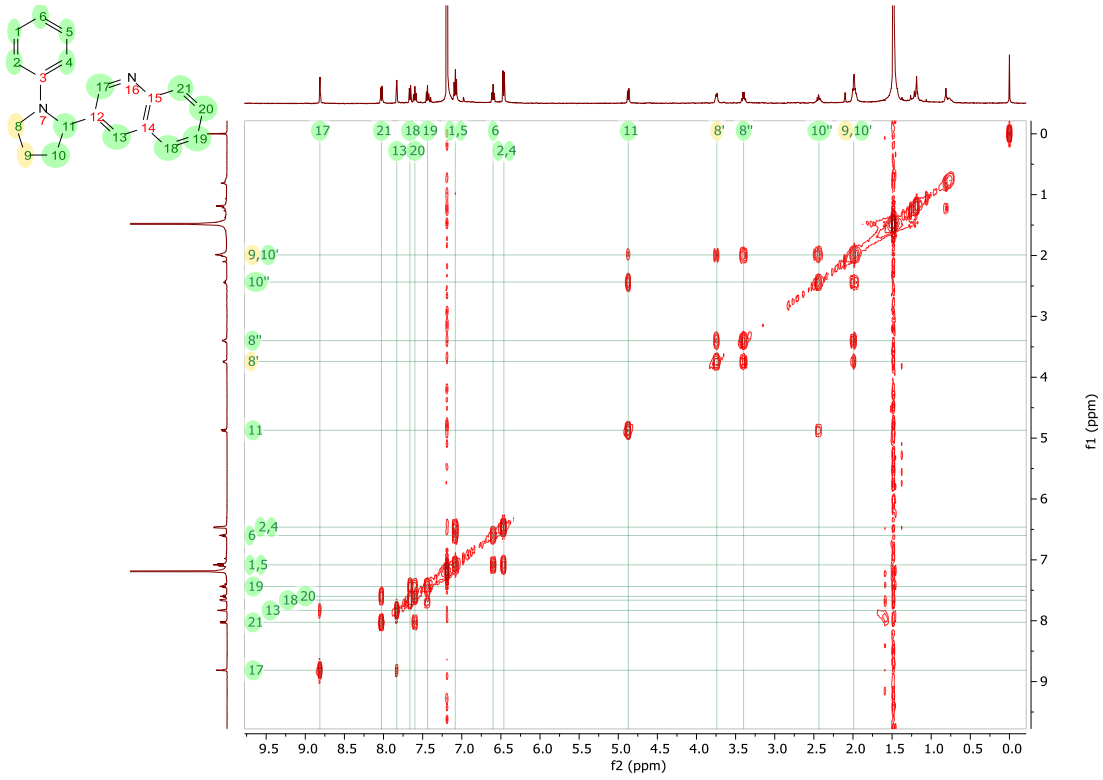
Spectrum 31 The COSY NMR of **15**.



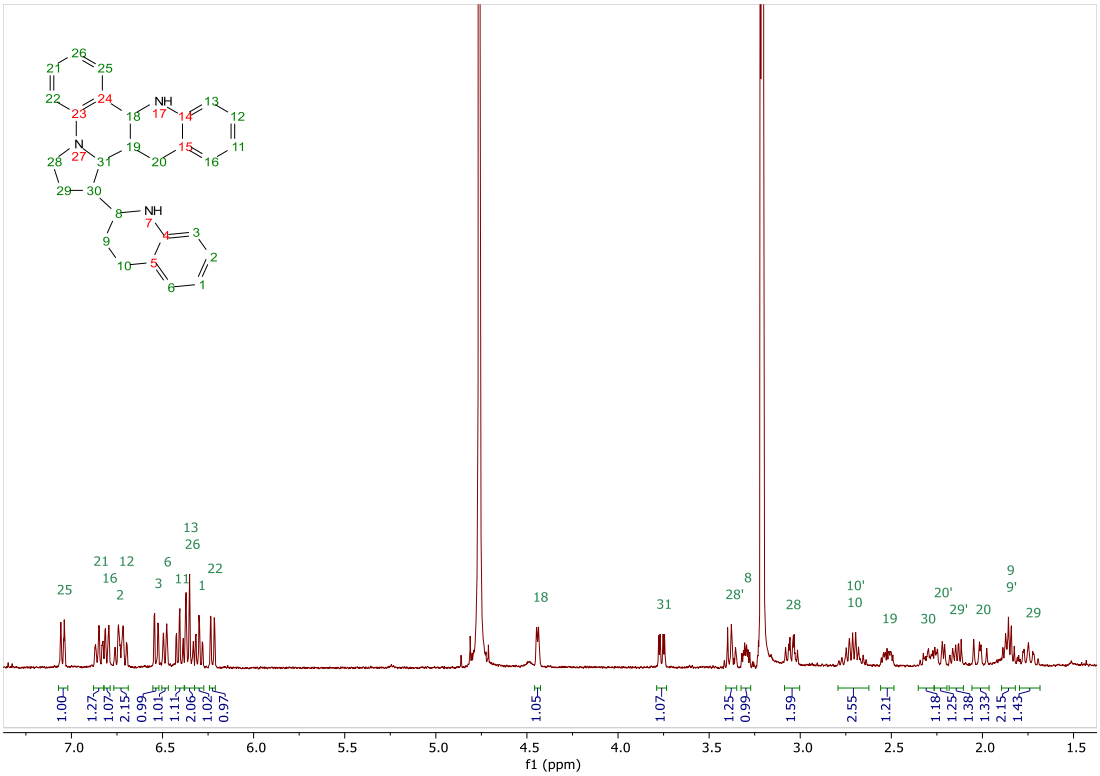
Spectrum 32 The HSQC NMR of **15**.



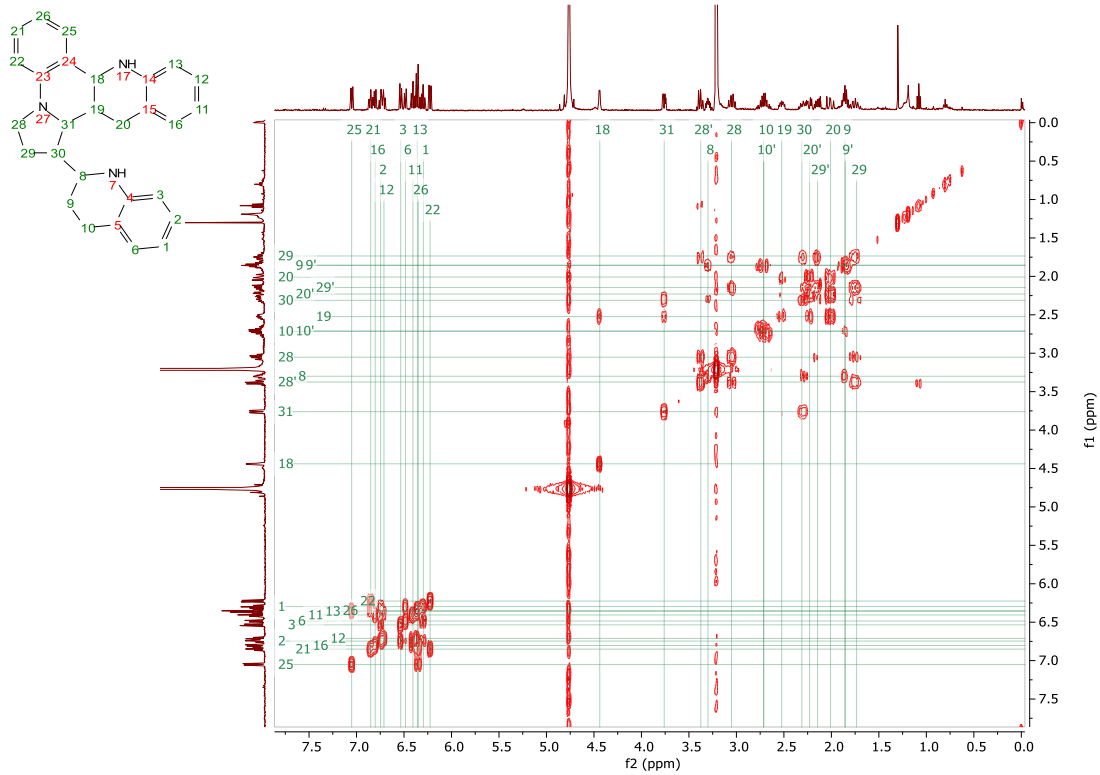
Spectrum 33 The ^{1}H NMR of **16**.



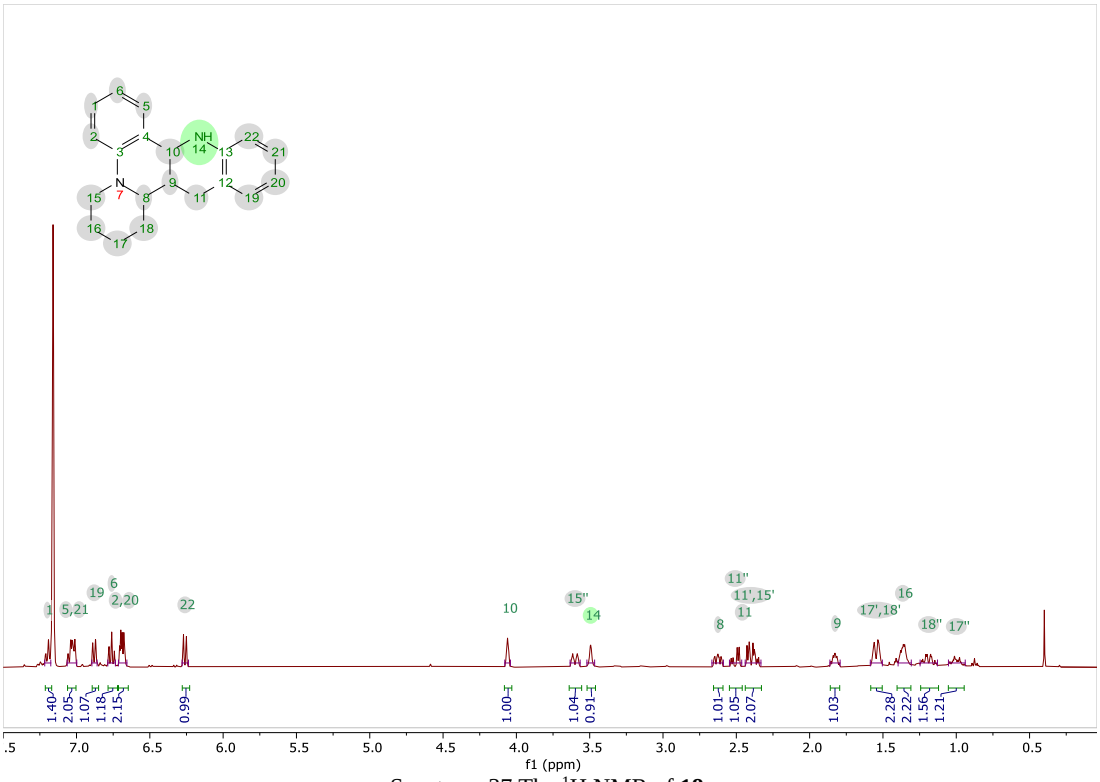
Spectrum 34 The COSY NMR of **16**.



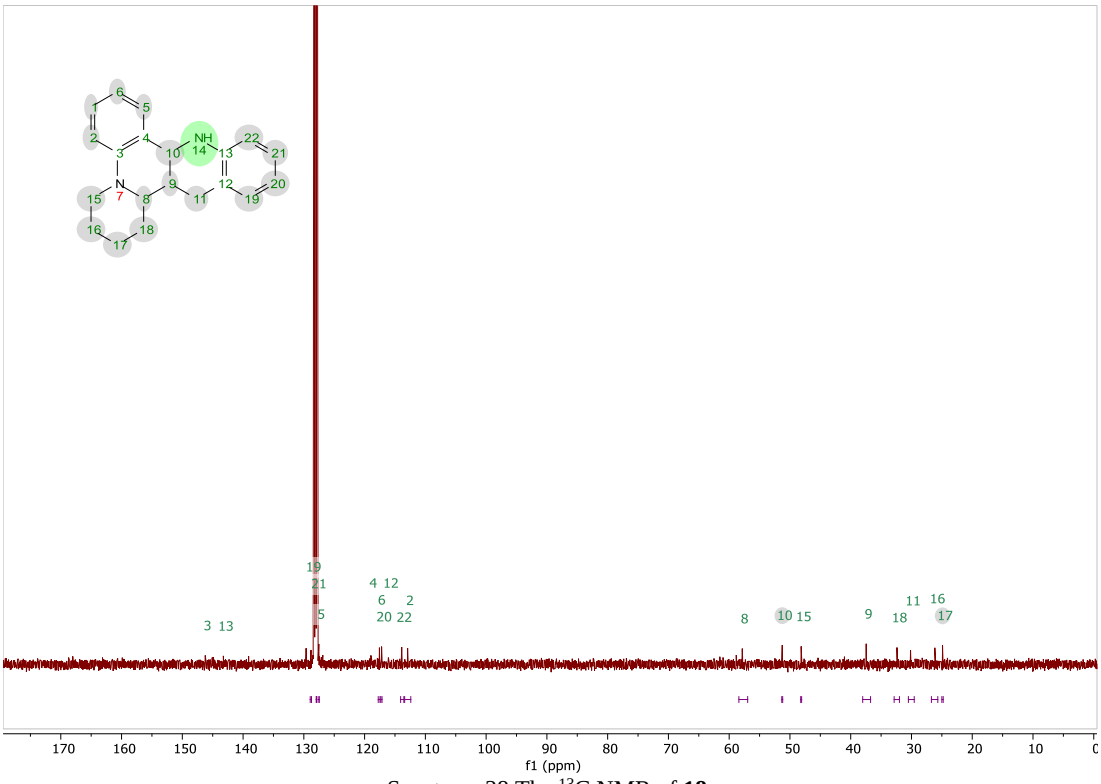
Spectrum 35 The ^{1}H NMR of **17**.



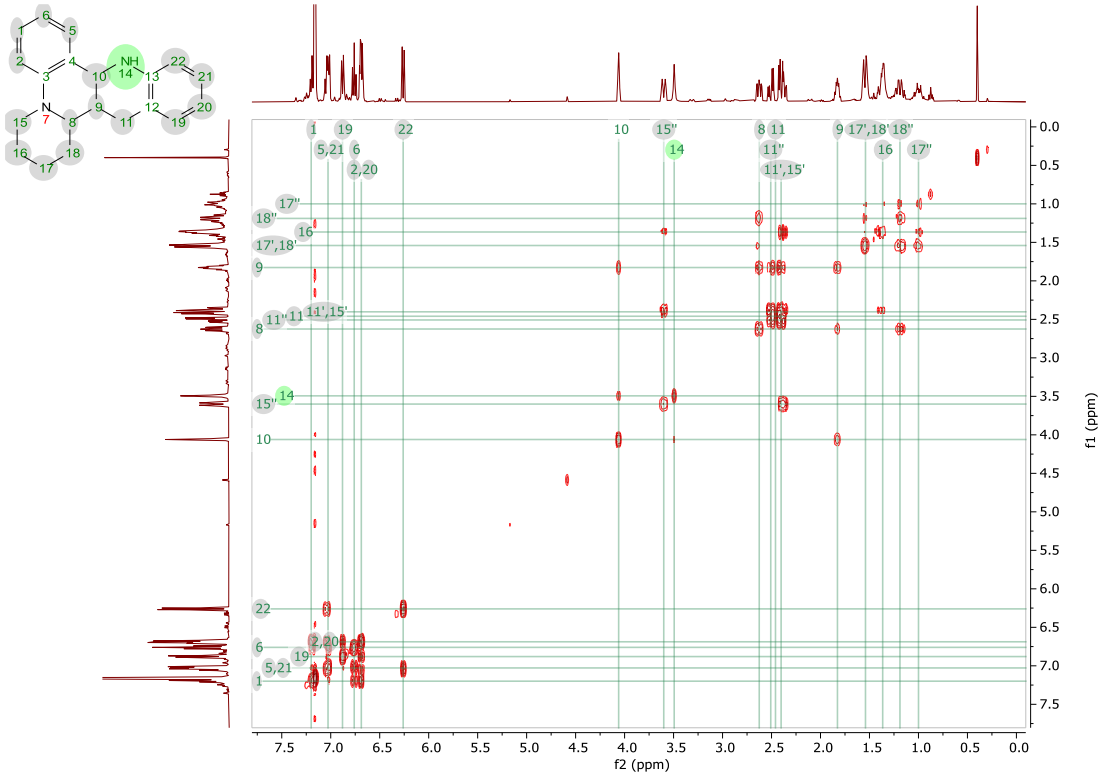
Spectrum 36 The COSY NMR of **17**.



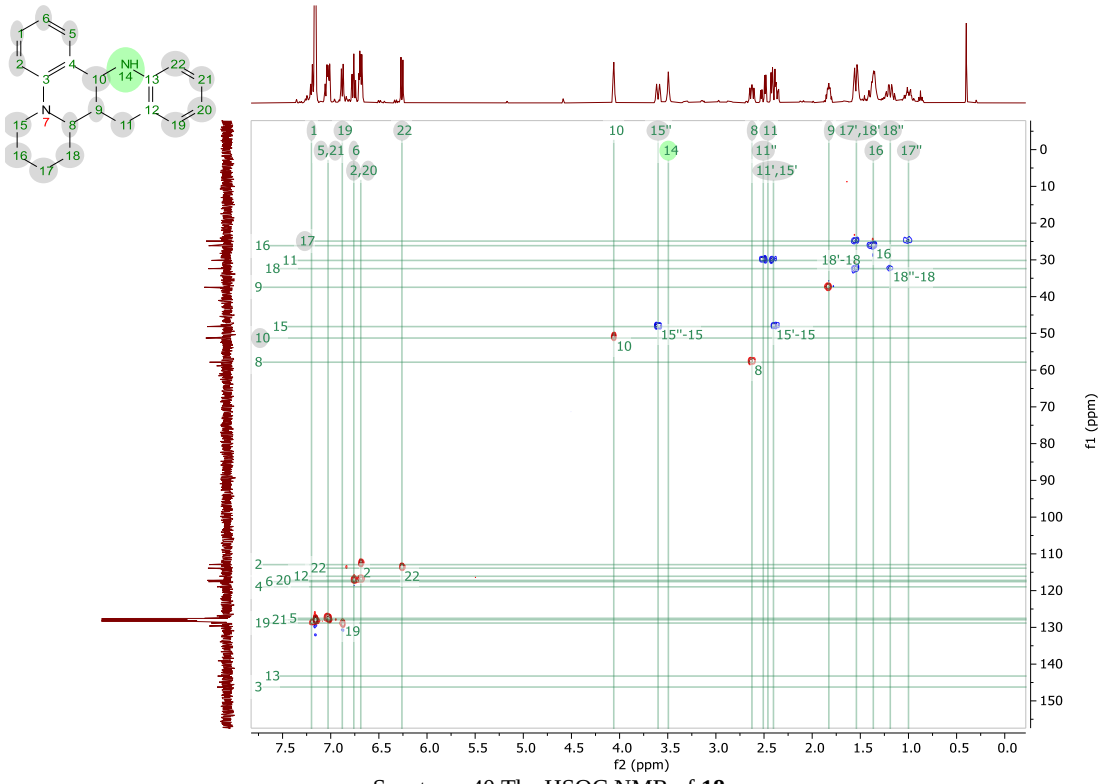
Spectrum 37 The ^{1}H NMR of **18**.



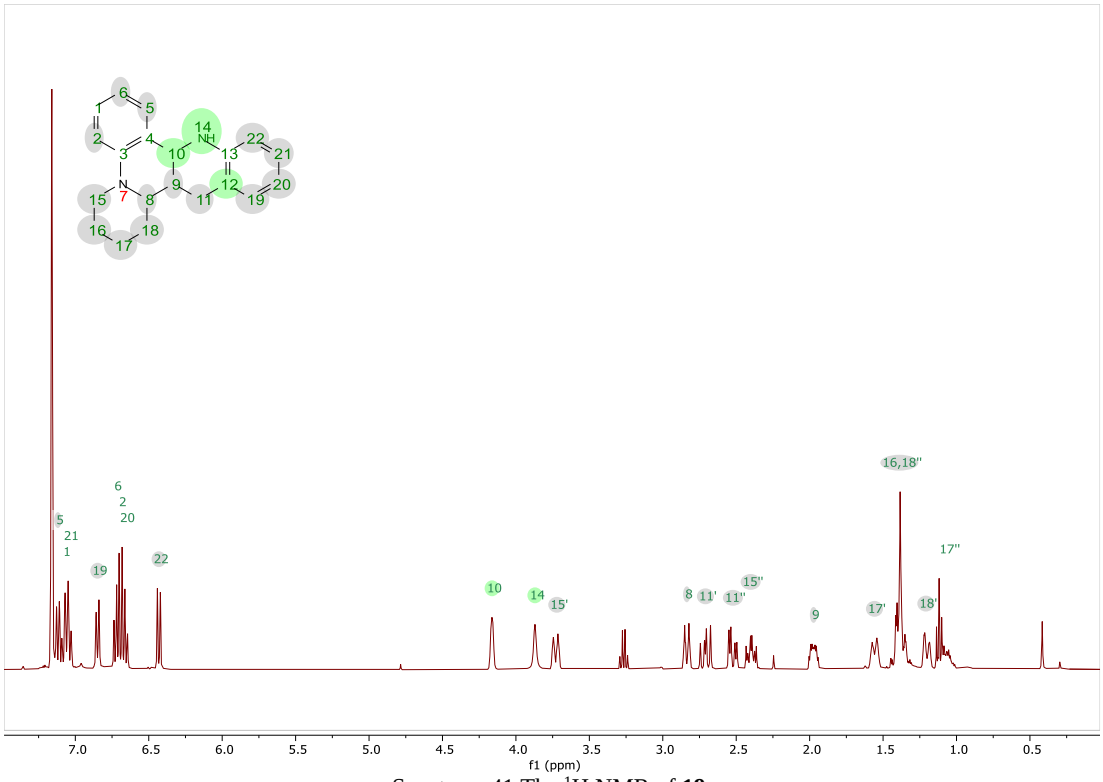
Spectrum 38 The ^{13}C NMR of **18**.



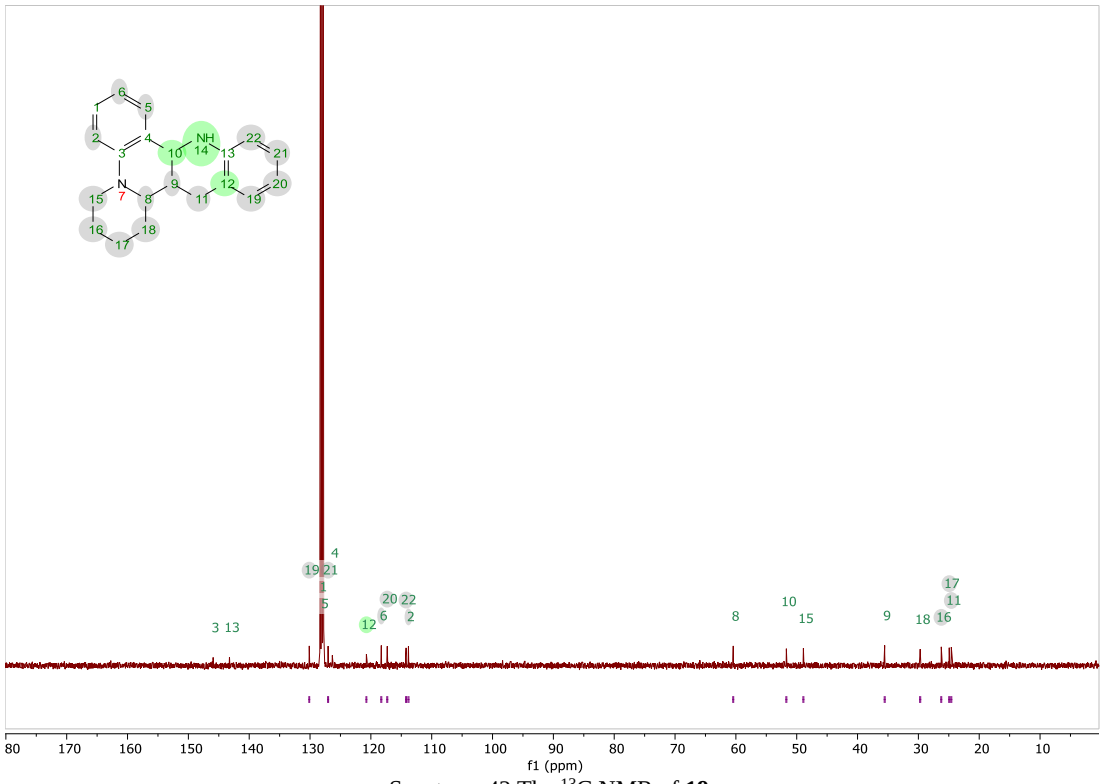
Spectrum 39 The COSY NMR of **18**.



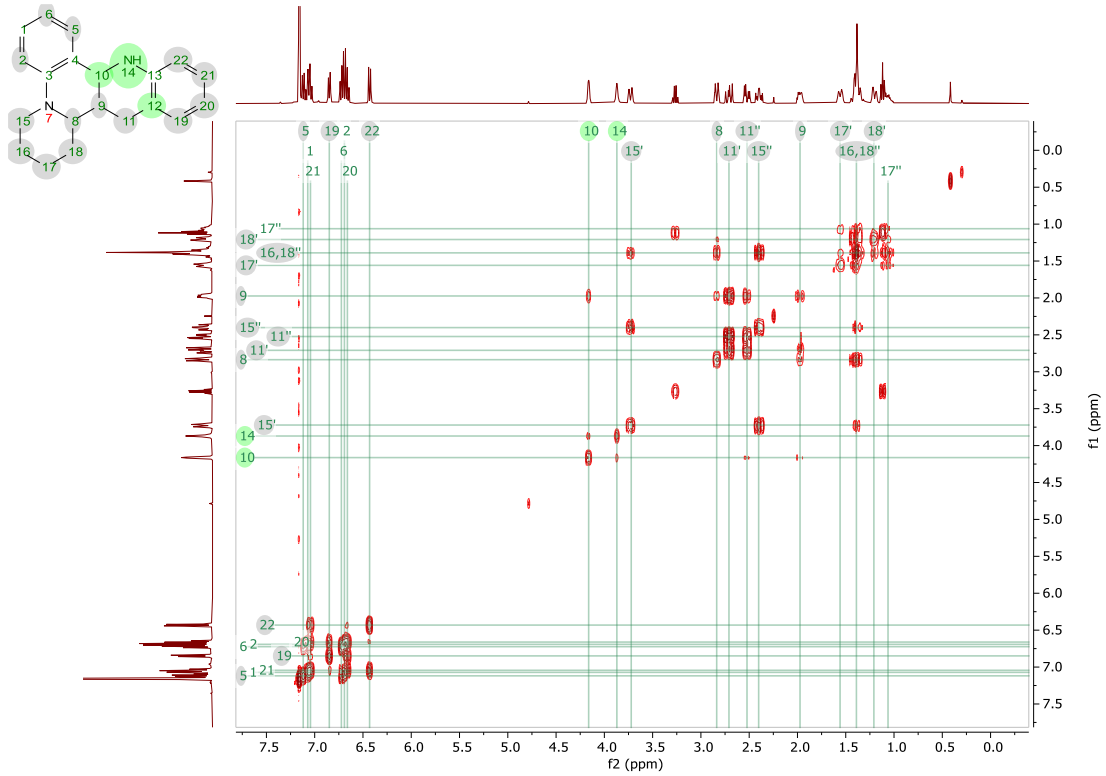
Spectrum 40 The HSQC NMR of **18**.



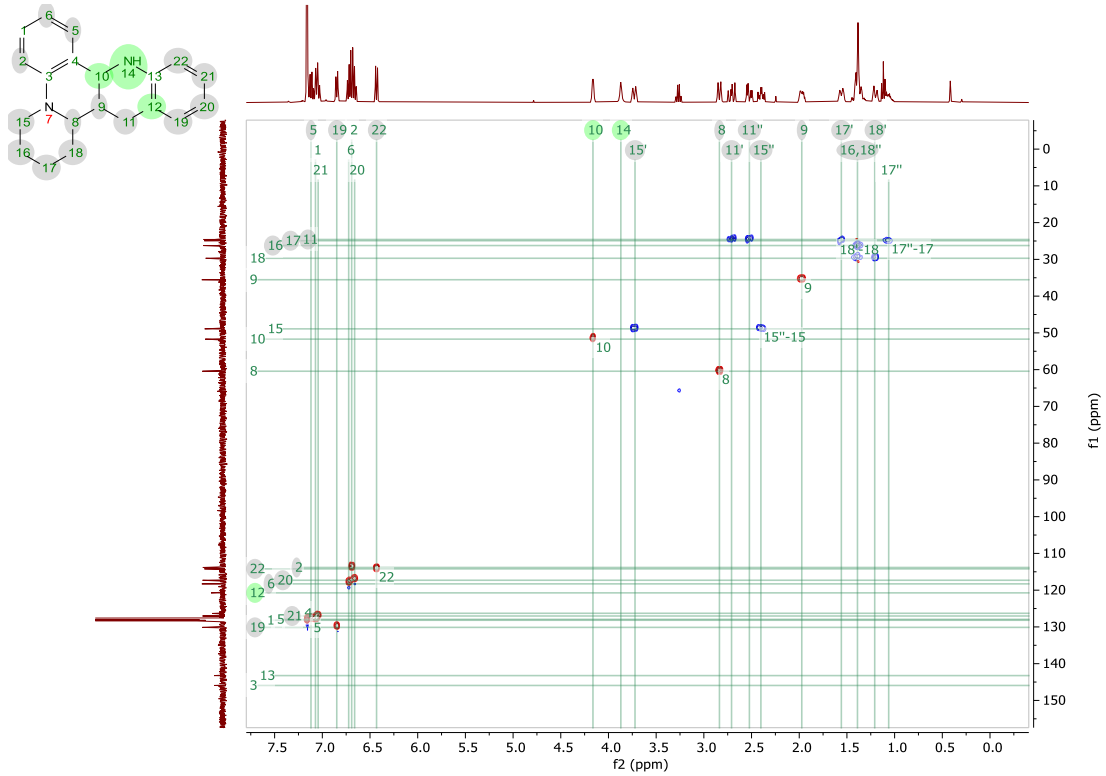
Spectrum 41 The ^{1}H NMR of **19**.



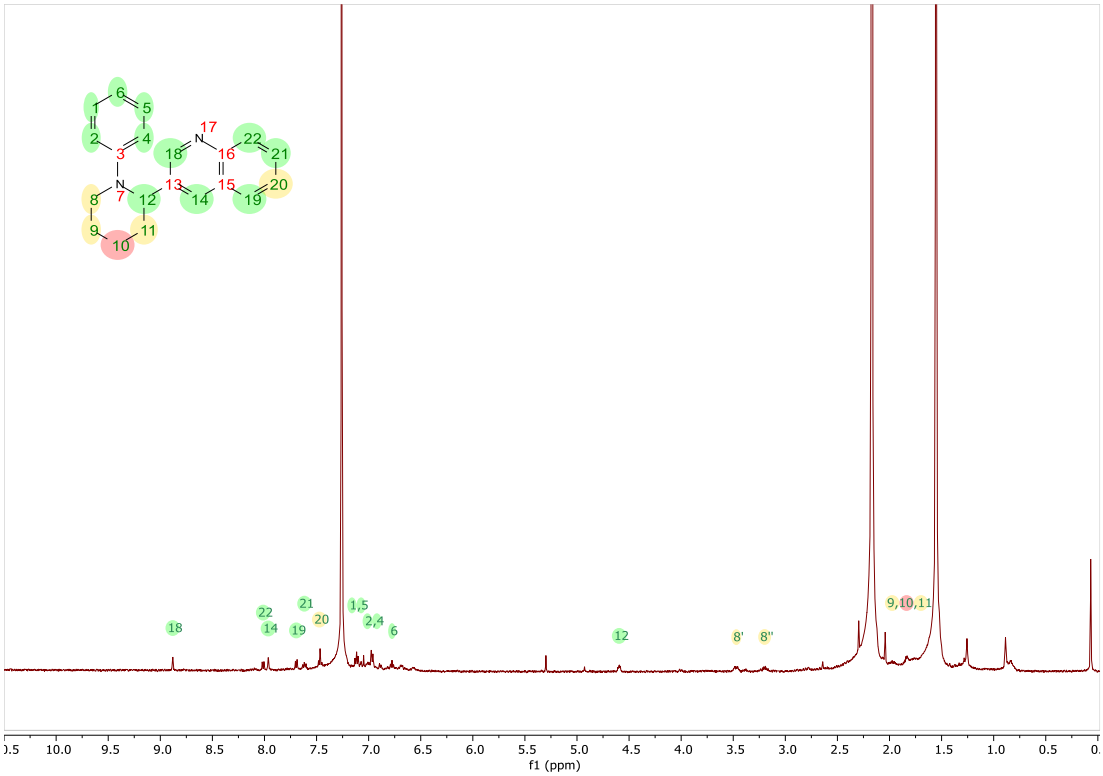
Spectrum 42 The ^{13}C NMR of **19**.



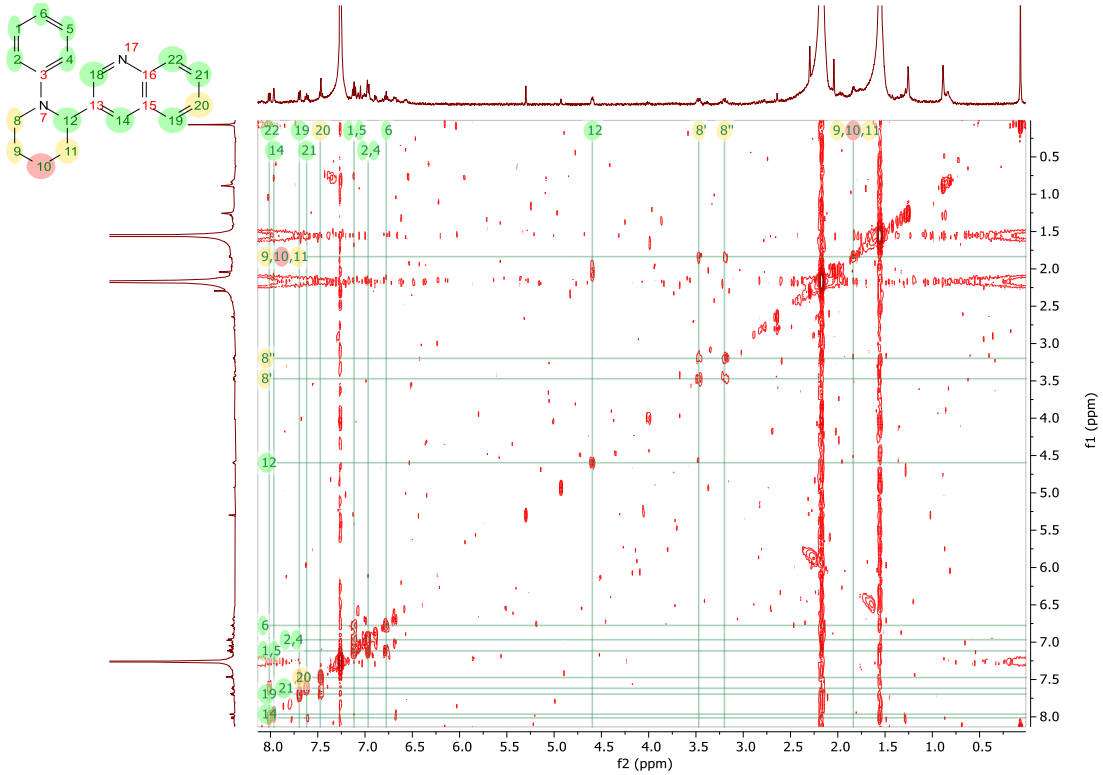
Spectrum 43 The COSY NMR of **19**.



Spectrum 44 The HSQC NMR of **19**.

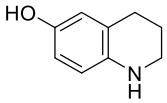


Spectrum 45 The ^{1}H NMR of **20**.



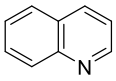
Spectrum 46 The COSY NMR of **20**.

Appendix 4.2 The NMR and MS data of the products in Chapter 4.



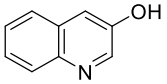
21

The title compound (**21**)[8] was obtained as a white solid (22.0 mg, 73% yield) using the described general method [from **13** (0.20 mmol) and the mutant R19/I263G/A328L (0.10 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography; ^{1}H NMR (500 MHz, CD_3OD) δ 6.48 – 6.40 (m, 3H), 4.59 (s, 1H), 3.16 – 3.13 (m, 2H), 2.69 (t, *J* = 6.5 Hz, 2H), 1.92 – 1.84 (m, 2H) ppm; ^{13}C NMR (125 MHz, CD_3OD) δ 150.7, 138.8, 125.4, 118.2, 116.8, 114.8, 43.4, 28.0, 23.6 ppm; HRMS (ESI^+) calc. for $C_9H_{12}ON$ $[MH]^+$ 150.0913, found 150.0913.



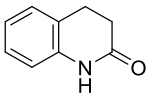
22

The title compound (**22**)[9] was obtained as a brown-red oil (17.6 mg, 68% yield) using the described general method [from **13** (0.20 mmol) and the variant K19/A82M/F87A/E267F (0.10 μmol) in phosphate buffer, 20 mL reaction volume] and purification by silica chromatography. ^{1}H NMR (400 MHz, CD_3OD) δ 8.82 (dd, *J* = 4.4 Hz, 1.7 Hz, 1H), 8.33 (ddd, *J* = 8.3 Hz, 1.8 Hz, 0.8 Hz, 1H), 8.01 (dt, *J* = 8.6 Hz, 0.9 Hz, 1H), 7.91 (dd, *J* = 8.2 Hz, 1.4 Hz, 1H), 7.75 (ddd, *J* = 8.4 Hz, 6.9 Hz, 1.5 Hz, 1H), 7.59 (ddd, *J* = 8.2 Hz, 6.9 Hz, 1.2 Hz, 1H), 7.50 (dd, *J* = 8.3 Hz, 4.3 Hz, 1H) ppm; ^{13}C NMR (101 MHz, CD_3OD) δ 151.1, 148.7, 138.4, 131.1, 129.9, 129.2, 129.0, 128.0, 122.5 ppm; HRMS (ESI^+) calc. for C_9H_8N $[MH]^+$ 130.0651, found 130.0650.



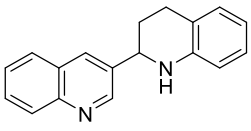
23

The title compound (**23**)[10] was obtained as a brown solid (1.5 mg, 1.1% yield) using the described general method [from **13** (1.0 mmol) and the variant R19/F87A/A328L (0.50 μmol) in phosphate buffer, 100.0 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (400 MHz, CD_3OD) δ 8.54 (br s, 1H), 7.97–7.86 (m, 1H), 7.74 (dd, *J* = 7.5 Hz, 2.1 Hz, 1H), 7.56–7.45 (m, 3H) ppm. ^{13}C NMR (101 MHz, CD_3OD) δ 144.4, 143.6, 128.8, 128.3, 127.7, 127.6, 117.9 ppm. HRMS (ESI^+) calc. for C_9H_8NO $[MH]^+$ 146.0600, found 146.0600.



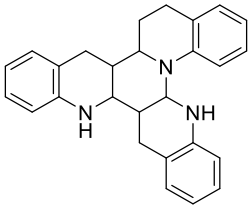
24

The title compound (**24**)[11] was obtained as a white solid (14.0 mg, 10% yield) using the described general method [from **13** (1.0 mmol) and the variant R19/F87A (0.50 μmol) in phosphate buffer, 100.0 mL reaction volume] and purification by silica gel. ^{1}H NMR (400 MHz, CD_3OD) δ 7.19 – 7.11 (m, 1H), 6.97 (td, *J* = 7.5 Hz, 1.2 Hz, 1H), 6.87 – 6.83 (m, 1H), 2.97 – 2.90 (m, 1H), 2.59 – 2.51 (m, 1H) ppm; ^{13}C NMR (100 MHz, CD_3OD) δ 174.0, 138.9, 128.9, 128.4, 125.2, 124.1, 116.5, 31.6, 26.2 ppm; HRMS (ESI^+) calc. for $C_9H_{10}NO$ $[MH]^+$ 148.0757, found 148.0756.



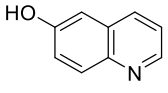
25

The title compound (**25**)[12] was obtained as a transparent oil (46.2 mg, 35% yield) using the described general method [from **13** (1.0 mmol) and the variant R19/F87A/A328L (0.50 μmol) in phosphate buffer, 100.0 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (500 MHz, CD_3OD) δ 8.90 (d, *J* = 2.2 Hz, 1H), 8.32 (d, *J* = 2.2 Hz, 1H), 8.02 (dd, *J* = 8.5 Hz, 1.0, 1H), 7.93 (dd, *J* = 8.2 Hz, 1.4 Hz, 1H), 7.75 (ddd, *J* = 8.5 Hz, 6.9 Hz, 1.5 Hz, 1H), 7.61 (ddd, *J* = 8.1 Hz, 6.9 Hz, 1.2 Hz, 1H), 7.05 – 6.89 (m, 2H), 6.66 (dd, *J* = 8.0 Hz, 1.2 Hz, 1H), 6.59 (td, *J* = 7.4 Hz, 1.2 Hz, 1H), 4.71 (dd, *J* = 8.5 Hz, 3.5 Hz, 1H), 2.92 (ddd, *J* = 15.5 Hz, 9.4 Hz, 5.3 Hz, 1H), 2.68 (dt, *J* = 16.4 Hz, 5.4 Hz, 1H), 2.23 (dtd, *J* = 12.9 Hz, 5.5 Hz, 3.5 Hz, 1H), 2.15 – 2.05 (m, 1H) ppm; ^{13}C NMR (125 MHz, CD_3OD) δ 151.0, 148.0, 146.2, 139.9, 135.4, 130.7, 130.1, 129.6, 129.2, 128.8, 128.2, 127.9, 121.7, 118.1, 115.4, 54.8, 31.7, 26.7 ppm; HRMS (ESI^+) calc. for $C_{18}H_{17}N_2$ $[MH]^+$ 261.1386, found 261.1384.



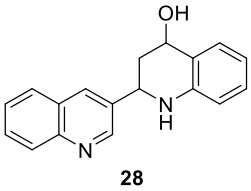
26

The title compound (**26**) was obtained as a transparent oil (5.4 mg, 4.1% yield) using the described general method [from **13** (1.0 mmol) and the variant R19/F87A/A328L (0.50 μmol) in phosphate buffer, 100.0 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.12 (td, *J* = 7.8, 7.1, 1.7 Hz, 1H), 7.07–7.01 (m, 2H), 6.98 (td, *J* = 8.3, 7.5, 2.6 Hz, 4H), 6.75 (td, *J* = 7.3, 1.0 Hz, 1H), 6.64 (tdd, *J* = 7.4, 3.3, 1.2 Hz, 2H), 6.57 (dd, *J* = 8.4, 1.2 Hz, 1H), 6.41 (dd, *J* = 8.1, 1.1 Hz, 1H), 5.72 (d, *J* = 3.6 Hz, 1H), 3.96 (s, 2H), 3.41 (td, *J* = 9.8, 3.5 Hz, 1H), 3.29 – 3.19 (m, 2H), 2.93 (dd, *J* = 14.5, 3.5 Hz, 2H), 2.80 (ddt, *J* = 20.5, 15.9, 4.7 Hz, 2H), 2.52 (dd, *J* = 16.0, 11.9 Hz, 1H), 2.31 (dt, *J* = 12.9, 4.2 Hz, 1H), 2.25 (dd, *J* = 10.5, 5.2 Hz, 1H), 1.92–1.82 (m, 1H), 1.82–1.71 (m, 1H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 129.78, 129.64, 129.51, 127.68, 127.49, 126.97, 118.56, 118.07, 117.81, 114.73, 113.92, 112.81, 64.15, 54.23, 50.41, 41.36, 37.77, 30.46, 28.75, 27.39, 26.16. HRMS (ESI^+) calc. for $C_{27}H_{28}N_3$ $[MH]^+$ 394.2278, found 394.2279.



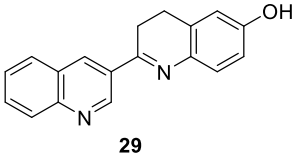
27

The title compound (**27**)[10] was obtained as a white solid (12.0 mg, 41% yield) using the described general method [from **21** (0.20 mmol) and the variant R19/I263G/A328L (0.10 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (500 MHz, CD_3OD) δ 8.61 (dd, *J* = 4.3 Hz, 1.6 Hz, 1H), 8.15 (dt, *J* = 8.3 Hz, 1.1 Hz, 1H), 7.88 (d, *J* = 9.1 Hz, 1H), 7.42 (dd, *J* = 8.4 Hz, 4.3 Hz, 1H), 7.35 (dd, *J* = 9.1 Hz, 2.7 Hz, 1H), 7.14 (d, *J* = 2.7 Hz, 1H) ppm; ^{13}C NMR (125 MHz, CD_3OD) δ 157.4, 147.9, 144.0, 136.6, 131.4, 130.4, 123.5, 122.6, 109.6 ppm; HRMS (ESI^+) calc. for C_9H_8NO $[MH]^+$ 146.0600, found 146.0601.



28

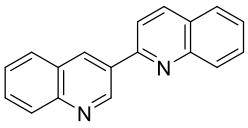
The title compound (**28**)[12] was obtained as a pale yellow solid (9.5 mg mixture of *syn*- and *anti*-**28**, 37% yield) using the described general method [from **25** (0.10 mmol) and the variant R19/F87A/A328I (0.10 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. *Syn*-**27**: ^{1}H NMR (500 MHz, CD_3OD) δ 8.86 (d, *J* = 2.2 Hz, 1H), 8.32 (d, *J* = 2.1 Hz, 1H), 7.94 (d, *J* = 8.5 Hz, 1H), 7.87 (dd, *J* = 8.0 Hz, 1.4 Hz, 1H), 7.66 (ddd, *J* = 8.5 Hz, 6.9 Hz, 1.5 Hz, 1H), 7.53 (ddd, *J* = 8.0 Hz, 6.8 Hz, 1.2 Hz, 1H), 7.27 (dt, *J* = 7.6 Hz, 1.3 Hz, 1H), 6.95–6.87 (m, 1H), 6.60 (td, *J* = 7.5 Hz, 1.2 Hz, 1H), 6.55 (dd, *J* = 8.0 Hz, 1.1 Hz, 1H), 4.98 (dd, *J* = 10.4 Hz, 5.8 Hz, 1H), 2.32 (ddd, *J* = 12.4 Hz, 5.7 Hz, 2.8 Hz, 1H), 2.03 (ddd, *J* = 12.3 Hz, 11.4 Hz, 10.3 Hz, 1H) ppm; ^{13}C NMR (125 MHz, CD_3OD) δ 149.7, 146.8, 144.7, 137.4, 134.1, 129.4, 127.8, 127.7, 127.4, 126.9, 126.5, 124.3, 117.2, 114.2, 66.3, 53.3, 40.8 ppm; HRMS (ESI^+) calc. for $C_{18}H_{17}N_2O$ $[MH]^+$ 277.1335, found 277.1336. *Anti*-**27**: ^{1}H NMR (500 MHz, CD_3OD) δ 8.97 (d, *J* = 2.2 Hz, 1H), 8.43 (d, *J* = 2.1 Hz, 1H), 8.04 (dq, *J* = 8.5 Hz, 0.9 Hz, 1H), 7.97 (dd, *J* = 8.1 Hz, 1.4 Hz, 1H), 7.77 (ddd, *J* = 8.4 Hz, 6.9 Hz, 1.4 Hz, 1H), 7.63 (ddd, *J* = 8.2 Hz, 6.9 Hz, 1.2 Hz, 1H), 7.24 (dd, *J* = 7.6 Hz, 1.6 Hz, 1H), 7.08 (ddd, *J* = 8.0 Hz, 7.2 Hz, 1.6 Hz, 1H), 6.73 (dd, *J* = 8.1 Hz, 1.1 Hz, 1H), 6.69 (td, *J* = 7.4 Hz, 1.2 Hz, 1H), 4.79 (dd, *J* = 11.9 Hz, 2.9 Hz, 2H), 4.74 (t, *J* = 3.2 Hz, 1H), 2.21 (dt, *J* = 13.4 Hz, 3.0 Hz, 1H), 2.06 (ddd, *J* = 13.5 Hz, 11.9 Hz, 3.4 Hz, 1H); ^{13}C NMR (125 MHz, CD_3OD) δ 149.8, 146.8, 145.1, 137.5, 134.4, 130.0, 129.5, 128.6, 128.3, 127.8, 127.4, 126.9, 121.9, 116.9, 114.7, 64.7, 49.1, 39.5 ppm; HRMS (ESI^+) calc. for $C_{18}H_{17}N_2O$ $[MH]^+$ 277.1335, found 277.1332.



29

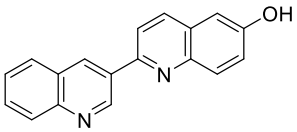
The title compound (**29**) was obtained as a white solid (1.0 mg in the 1 : 0.9 mixture of **31** and **29**, 3.8% yield) using the described general method [from **25** (0.10 mmol) and the variant R19/F87A/A328I (0.10 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification

by silica gel chromatography. ^{1}H NMR (400 MHz, MeOD) δ 9.56 (d, *J* = 2.2 Hz, 1H), 8.79 (d, *J* = 2.3 Hz, 1H), 8.09–8.05 (m, 2H), 7.83 (tdd, *J* = 7.0, 3.8, 2.0 Hz, 1H), 7.70–7.65 (m, 1H), 7.30 (d, *J* = 8.4 Hz, 1H), 6.72 (dd, *J* = 8.4, 2.8 Hz, 1H), 6.66 (d, *J* = 2.8 Hz, 1H), 3.00 (ddd, *J* = 9.4, 7.5, 1.9 Hz, 2H), 2.90 (t, *J* = 8.2 Hz, 2H) ppm. HRMS (ESI$^+$) calc. for $C_{18}H_{15}N_2O$ [MH]$^+$ 275.1179, found 275.1.



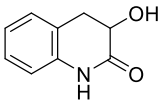
30

The title compound (**30**)[13] was obtained as a transparent oil (1.8 mg, 39% yield) using the described general method [from *cis*-**28** (5.0 mg, 18 μmol) and the variant R19/F87A/A328I (0.10 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (500 MHz, CD_3OD) δ 9.65 (d, *J* = 2.2 Hz, 1H), 9.01 (d, *J* = 2.2 Hz, 1H), 8.40 (d, *J* = 8.5 Hz, 1H), 8.15 (d, *J* = 8.5 Hz, 1H), 8.10 (dd, *J* = 8.4 Hz, 1.0 Hz, 1H), 8.06–8.04 (m, 1H), 8.04–8.01 (m, 1H), 7.90 (dd, *J* = 8.1 Hz, 1.4 Hz, 1H), 7.79 – 7.75 (m, 1H), 7.75–7.70 (m, 1H), 7.62 (ddd, *J* = 8.1 Hz, 6.9 Hz, 1.2 Hz, 1H), 7.54 (ddd, *J* = 8.1 Hz, 6.9 Hz, 1.2 Hz, 1H) ppm; ^{13}C NMR (125 MHz, CD_3OD) δ 156.5, 154.5, 154.4, 149.3, 148.1, 137.7, 135.4, 132.1, 130.6, 130.0, 128.8, 128.7, 128.0, 127.6, 127.6, 127.3, 126.8, 118.8 ppm; HRMS (ESI$^+$) calc. for $C_{18}H_{13}N_2$ [MH]$^+$ 257.1073, found 257.1073.



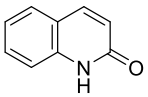
31

The title compound (**31**) was obtained as a transparent oil (1.2 mg, 4.6% yield) using the described general method [from **25** (0.10 mmol) and the variant R19/F87A/A328I (0.10 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (400 MHz, MeOD) δ 9.67 (d, *J* = 2.2 Hz, 1H), 9.00 (d, *J* = 2.2 Hz, 1H), 8.26 (d, *J* = 8.6 Hz, 1H), 8.17–8.07 (m, 3H), 8.04 (d, *J* = 9.1 Hz, 1H), 7.83 (t, *J* = 7.8 Hz, 1H), 7.69 (t, *J* = 7.5 Hz, 1H), 7.39 (dd, *J* = 9.1, 2.7 Hz, 1H), 7.19 (d, *J* = 2.7 Hz, 1H) ppm. HRMS (ESI$^+$) calc. for $C_{18}H_{13}N_2O$ [MH]$^+$ 273.1022, found 273.0.



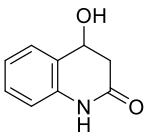
32

The title compound (**32**)[14] was obtained as a white solid (0.5 mg, 2% yield) using the described general method [from **24** (0.20 mmol) and the variant RP/H171L/I263G (0.10 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (500 MHz, CD_3OD) δ 7.22–7.15 (m, 2H), 6.98 (td, *J* = 7.5 Hz, 1.2 Hz, 1H), 6.88–6.84 (m, 1H), 4.28 (dd, *J* = 12.8 Hz, 6.5 Hz, 1H), 3.13 (dd, *J* = 15.3 Hz, 6.4 Hz, 1H), 2.99–2.91 (m, 1H)) ppm. HRMS (ESI$^+$) calc. for $C_9H_{10}NO_2$ [MH]$^+$ 164.0706, found 164.0705.



33

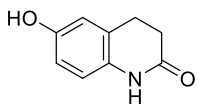
The title compound (**33**)[15] was obtained as a yellow solid (2.0 mg, 7% yield) using the described general method [from **24** (0.20 mmol) and the variant RP/H171L/I263G (0.10 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (500 MHz, CD_3OD) δ 7.87 (d, *J* = 9.4 Hz, 1H), 7.58 (dd, *J* = 7.7 Hz, 1.4 Hz, 1H), 7.45 (ddd, *J* = 8.4 Hz, 7.2 Hz, 1.4 Hz, 1H), 7.26 (d, *J* = 8.3 Hz, 1H), 7.17 (ddd, *J* = 8.1 Hz, 7.2 Hz, 1.1 Hz, 1H), 6.52 (d, *J* = 9.5 Hz, 1H) ppm. ^{13}C NMR (125 MHz, CD_3OD) δ 164.4, 141.4, 137.1, 130.6, 127.8, 122.6, 120.4, 120.0, 115.3 ppm. HRMS (ESI$^+$) calc. for C_9H_8NO [MH]$^+$ 146.0600, found 146.0600.



34

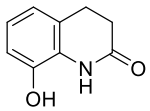
The title compound (**34**)[12] was obtained as a light yellow solid (1.2 mg, 4% yield) using the described general method [from **24** (0.20 mmol) and the variant RP/H171L/I263G (0.10 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (500 MHz, CD_3OD) δ 7.37 (dd, *J* = 7.5 Hz, 1.4 Hz, 1H), 7.26 (td, *J* = 7.7 Hz, 1.5 Hz, 1H), 7.06 (td, *J* = 7.5 Hz, 1.2 Hz, 1H), 6.92 (dd, *J* = 7.9 Hz, 1.1 Hz, 1H), 2.81 (dd, *J* = 16.4 Hz, 4.6 Hz, 1H), 2.71

(dd, *J* = 16.5 Hz, 4.9 Hz, 1H) ppm. ^{13}C NMR (125 MHz, CD_3OD) δ 172.0, 138.2, 130.2, 129.0, 124.2, 121.3, 116.9, 66.9, 40.6 ppm. HRMS (ESI^+) calc. for $C_9H_{10}NO_2$ $[MH]^+$ 164.0706, found 164.0706.



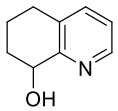
35

The title compound (**35**)[16] was obtained as a brown-white solid (1.5 mg, 5% yield) using the described general method [from **24** (0.20 mmol) and the variant RP/H171L/I263G (0.10 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (500 MHz, CD_3OD) δ 6.60 (d, *J* = 8.4 Hz, 1H), 6.53 (d, *J* = 2.7 Hz, 1H), 6.49 (dd, *J* = 8.4 Hz, 2.7, 1H), 2.77 (t, *J* = 7.6 Hz, 2H), 2.41 (dd, *J* = 8.5 Hz, 6.7 Hz, 2H) ppm. HRMS (ESI^+) calc. for $C_9H_{10}NO_2$ $[MH]^+$ 164.0706, found 164.0706.



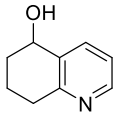
36

The title compound (**36**)[17] was obtained as a brown-white solid (2.3 mg, 7% yield) using the described general method [from **5** (0.20 mmol) and the variant RT2/S72H/A330W (0.10 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (400 MHz, CD_3OD) δ 6.81 (dd, *J* = 8.1 Hz, 7.4 Hz, 1H), 6.72 – 6.65 (m, 2H), 2.95–2.90 (m, 3H), 2.59–2.54 (m, 2H) ppm. HRMS (ESI^+) calc. for $C_9H_{10}NO_2$ $[MH]^+$ 164.0706, found 164.0707.



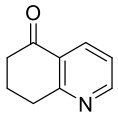
39

The title compound (**39**)[18] was obtained as a pale crystal (20.4 mg, 68% yield) using the described general method [from **38** (0.20 mmol) and the variant R19/F87I/R398H (0.10 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (500 MHz, $CDCl_3$) δ 8.39 (dd, *J* = 4.8, 1.8 Hz, 1H), 7.77 (dd, *J* = 7.8, 1.8 Hz, 1H), 7.12 (dd, *J* = 7.8, 4.8 Hz, 1H), 4.80 (t, *J* = 4.7 Hz, 1H), 3.00–2.83 (m, 2H), 2.11–2.00 (m, 2H), 1.94–1.78 (m, 3H) ppm. ^{13}C NMR (126 MHz, $CDCl_3$) δ 156.97, 148.32, 136.23, 134.36, 121.37, 67.76, 32.09, 32.04, 18.62 ppm. HRMS (ESI^+) calc. for $C_9H_{12}NO$ $[MH]^+$ 150.0913, found 150.1.



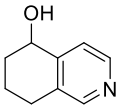
40

The title compound (**40**)[19] was obtained as a pale crystal (5.8 mg, 19% yield) using the described general method [from **38** (0.20 mmol) and the variant R19/F87I/R398H (0.10 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (500 MHz, $CDCl_3$) δ 8.41 (d, *J* = 4.8 Hz, 1H), 7.41 (d, *J* = 7.7 Hz, 1H), 7.12 (dd, *J* = 7.7, 4.7 Hz, 1H), 4.70 (t, *J* = 7.1 Hz, 1H), 4.00 (s, 1H), 2.81 (tt, *J* = 16.5, 8.9 Hz, 2H), 2.30 (dt, *J* = 10.6, 6.4 Hz, 1H), 2.05–1.94 (m, 1H), 1.88–1.75 (m, 2H) ppm. ^{13}C NMR (126 MHz, $CDCl_3$) δ 158.15, 146.84, 137.00, 131.69, 122.56, 69.14, 30.79, 28.47, 19.60 ppm. HRMS (ESI^+) calc. for $C_9H_{12}NO$ $[MH]^+$ 150.0913, found 150.1.



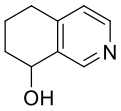
41

The title compound (**41**)[20] was obtained as a light yellow oil (2.4 mg, 8% yield) using the described general method [from **38** (0.20 mmol) and the variant K19/A82M/F87A (0.10 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (500 MHz, $CDCl_3$) δ 8.68 (dd, *J* = 4.8, 1.9 Hz, 1H), 8.28 (dd, *J* = 7.9, 1.8 Hz, 1H), 7.29 (dd, *J* = 7.9, 4.8 Hz, 1H), 3.17 (t, *J* = 6.2 Hz, 2H), 2.71 (dd, *J* = 7.4, 5.8 Hz, 2H), 2.21 (p, *J* = 6.5 Hz, 2H) ppm. ^{13}C NMR (126 MHz, $CDCl_3$) δ 198.12, 163.82, 153.67, 135.18, 128.32, 122.40, 38.72, 32.72, 22.02 ppm. HRMS (ESI^+) calc. for $C_9H_{10}NO$ $[MH]^+$ 148.0757, found 148.0760.



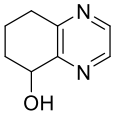
43

The title compound (**43**)[21] was obtained as a pale yellow solid (5.8 mg, 22% yield) using the described general method [from **42** (0.20 mmol) and the variant RP/H171L/I263G (0.10 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (500 MHz, $CDCl_3$) δ 8.41 (d, *J* = 5.1 Hz, 1H), 8.36 (s, 1H), 7.38 (d, *J* = 5.0 Hz, 1H), 4.74 (t, *J* = 6.1 Hz, 1H), 2.77 (qt, *J* = 16.6, 6.2 Hz, 2H), 2.11 (dtt, *J* = 16.1, 8.2, 3.6 Hz, 1H), 2.06–1.94 (m, 1H), 1.88–1.75 (m, 2H) ppm. HRMS (ESI$^+$) calc. for $C_9H_{12}NO$ $[MH]^+$ 150.0913, found 150.1.



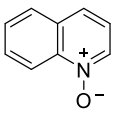
44

The title compound (**44**)[22] was obtained as a pale yellow solid (5.0 mg, 19% yield) using the described general method [from **42** (0.20 mmol) and the variant RP/H171L/I263G (0.10 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (500 MHz, $CDCl_3$) δ 8.64 (s, 1H), 8.36 (d, *J* = 5.1 Hz, 1H), 7.01 (d, *J* = 5.1 Hz, 1H), 4.87 (t, *J* = 4.5 Hz, 1H), 2.81 (dt, *J* = 18.1, 5.0 Hz, 1H), 2.75–2.65 (m, 1H), 2.06–1.90 (m, 3H), 1.85–1.75 (m, 1H) ppm. ^{13}C NMR (126 MHz, $CDCl_3$) δ 150.55, 148.23, 146.15, 134.60, 123.65, 65.85, 31.89, 28.48, 17.95. HRMS (ESI$^+$) calc. for $C_9H_{12}NO$ $[MH]^+$ 150.0913, found 150.1.



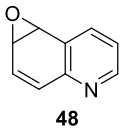
46

The title compound (**46**)[23] was obtained as a pale yellow solid (13.5 mg, 51% yield) using the described general method [from **45** (0.20 mmol) and the variant RP/H171L/I263G (0.10 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (500 MHz, $CDCl_3$) δ 8.40 (dd, *J* = 23.1, 2.5 Hz, 2H), 4.79 (dd, *J* = 8.5, 5.3 Hz, 1H), 3.62 (d, *J* = 1.6 Hz, 1H), 3.00 (dd, *J* = 7.4, 5.3 Hz, 2H), 2.37–2.27 (m, 1H), 2.17–2.08 (m, 1H), 1.96–1.80 (m, 2H) ppm. ^{13}C NMR (126 MHz, $CDCl_3$) δ 153.74, 153.02, 143.48, 141.68, 68.98, 31.68, 30.45, 18.88 ppm. HRMS (ESI$^+$) calc. for $C_8H_{11}N_2O$ $[MH]^+$ 151.0866, found 151.1.



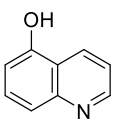
47

The title compound (**47**)[24] was obtained as a yellow oil (4.5 mg, 21% yield) using the described general method [from **22** (0.20 mmol) and the variant R19/F87A (0.10 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (400 MHz, MeOD) δ 8.70 (dd, *J* = 6.0, 1.1 Hz, 1H), 8.66 (dq, *J* = 8.9, 1.0 Hz, 1H), 8.18 (dt, *J* = 8.5, 1.1 Hz, 1H), 8.13–8.09 (m, 1H), 7.93 (ddd, *J* = 8.7, 7.0, 1.4 Hz, 1H), 7.80 (ddd, *J* = 8.2, 7.0, 1.2 Hz, 1H), 7.56 (dd, *J* = 8.5, 6.0 Hz, 1H) ppm. HRMS (ESI$^+$) calc. for C_9H_8NO $[MH]^+$ 146.0600, found 146.0601.



48

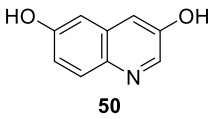
The title compound (**48**)[25] was obtained as a yellow oil (10.3 mg, 40% yield) using the described general method [from **22** (0.20 mmol) and the variant RP/V78I/F87V/I263G (0.10 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (400 MHz, MeOD) δ 6.99 (dd, *J* = 5.0, 1.7 Hz, 1H), 6.57 (ddd, *J* = 7.7, 1.7, 0.7 Hz, 1H), 5.83 (dd, *J* = 7.7, 4.9 Hz, 1H), 5.33 (ddd, *J* = 9.8, 1.8, 0.7 Hz, 1H), 5.27 (dd, *J* = 9.9, 3.8 Hz, 1H), 3.04 (d, *J* = 3.7 Hz, 1H), 2.63 (td, *J* = 3.8, 1.7 Hz, 1H) ppm. ^{13}C NMR (101 MHz, MeOD) δ 152.04, 150.10, 139.46, 132.83, 132.75, 130.58, 123.96, 57.33, 54.01 ppm. HRMS (ESI$^+$) calc. for C_9H_8NO $[MH]^+$ 146.0600, found 146.0600.



49

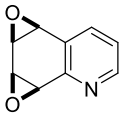
The title compound (**49**)[12] was obtained as a white solid (0.2 mg, 4% yield) using a drop of trifluoroacetic acid to treat with **22** (5 mg, 34 μmol) in 0.60 mL DCM, stirring at ambient temperature for 2 h, washed with saturated $NaHCO_3$ (2 × 0.60 mL) and brine (2 × 0.60 mL), and the organic layer was dried by anhydrous Na_2SO_4 and concentrated *in vacuo*. The crude mixture was then purification by silica gel chromatography. ^{1}H NMR (500 MHz, CD_3OD) δ 9.07 (d, *J* = 8.4 Hz, 1H), 8.96 (dd, *J* = 4.9

Hz, 1.7 Hz, 1H), 7.80 (t, *J* = 8.2 Hz, 1H), 7.73 (dd, *J* = 8.5 Hz, 5.0 Hz, 1H), 7.57 (dt, *J* = 8.5 Hz, 0.9, 1H), 7.09 (d, *J* = 7.8 Hz, 1H) ppm. HRMS (ESI$^+$) calc. for C_9H_8NO $[MH]^+$ 146.0600, found 146.0600.



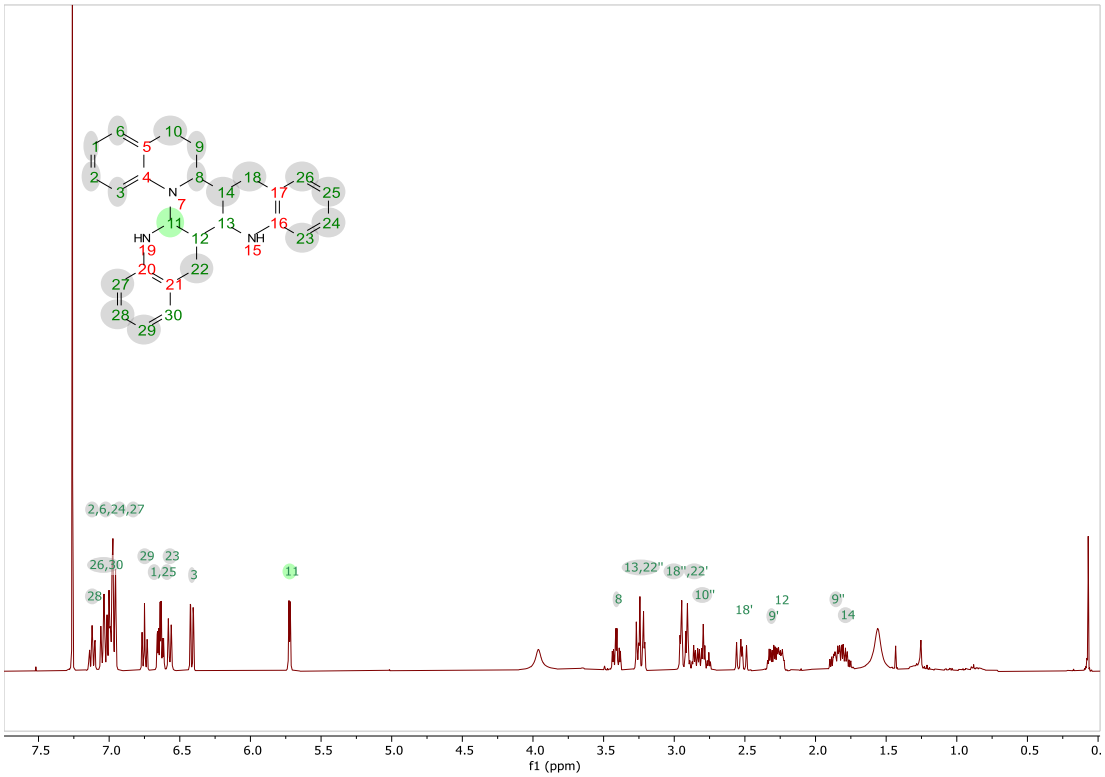
50

The title compound (**50**) was obtained as a yellow oil (2.1 mg, 40% yield) using the described general method [from **23** (0.08 mmol) and the variant R19/I263G/A328L (1.0 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (400 MHz, MeOD) δ 8.40 (d, *J* = 2.8 Hz, 1H), 7.61 (d, *J* = 8.9 Hz, 1H), 7.48 (dd, *J* = 2.8, 0.8 Hz, 1H), 7.21 (d, *J* = 2.4 Hz, 1H), 7.12 (dd, *J* = 8.9, 2.4 Hz, 1H) ppm. ^{13}C NMR (101 MHz, MeOD) δ 157.80, 157.08, 150.69, 143.81, 128.76, 125.24, 120.99, 118.81, 109.99 ppm. HRMS (ESI$^+$) calc. for $C_9H_8NO_2$ $[MH]^+$ 162.0550, found 162.0557.

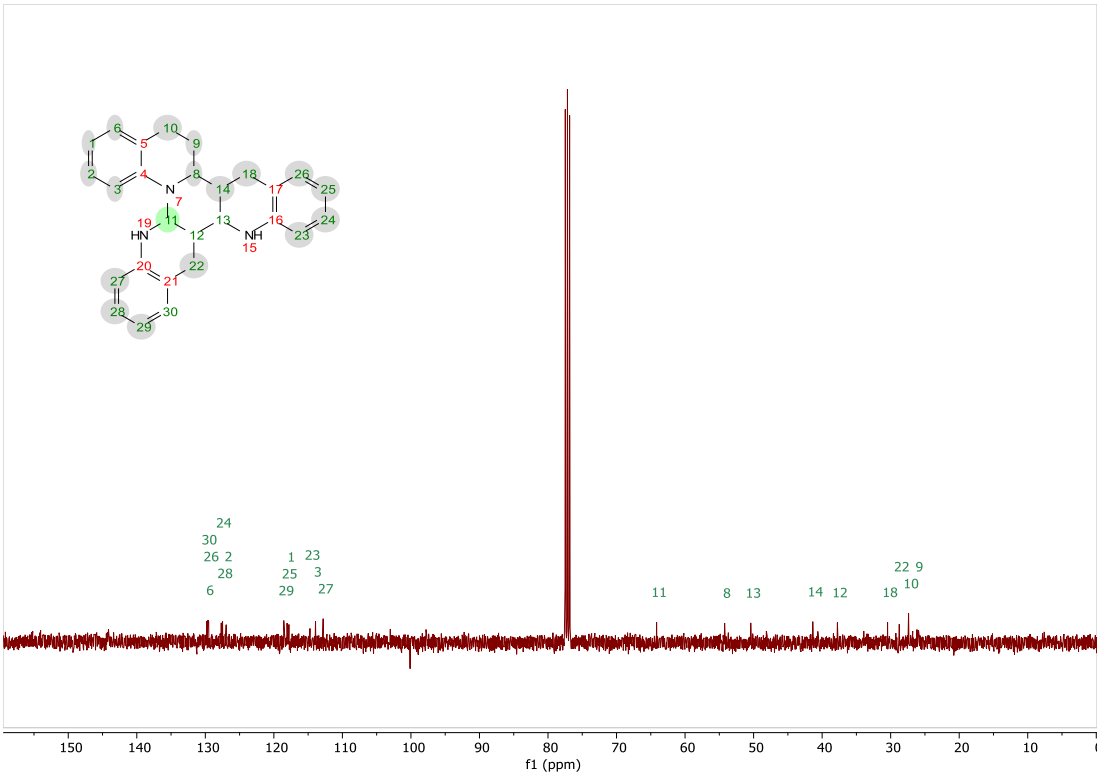


51

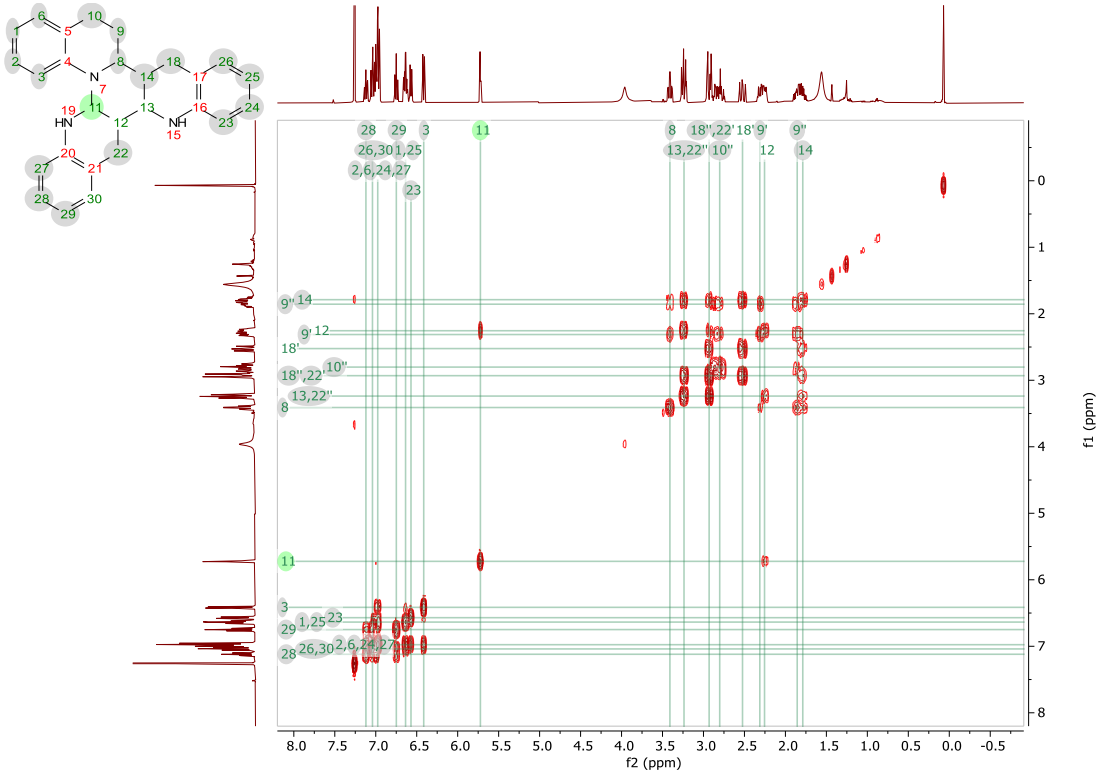
The title compound (**51**)[25] was obtained as a white solid (0.6 mg, 12% yield) using the described general method [from **48** (0.04 mmol) and the variant RP/V78I/F87V/I263G (0.04 μmol) in phosphate buffer, 10.0 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (400 MHz, MeOD) δ 8.49 (dd, *J* = 5.0, 1.6 Hz, 1H), 7.94 (dd, *J* = 7.6, 1.6 Hz, 1H), 7.42 (dd, *J* = 7.7, 5.0 Hz, 1H), 4.09 (ddd, *J* = 4.1, 1.9, 0.9 Hz, 1H), 4.04 (ddd, *J* = 4.0, 1.9, 0.8 Hz, 1H), 3.83 (dd, *J* = 4.0, 0.9 Hz, 1H), 3.80 (dt, *J* = 4.0, 0.7 Hz, 1H) ppm. HRMS (ESI$^+$) calc. for $C_9H_8NO_2$ $[MH]^+$ 162.0550, found 162.0557.



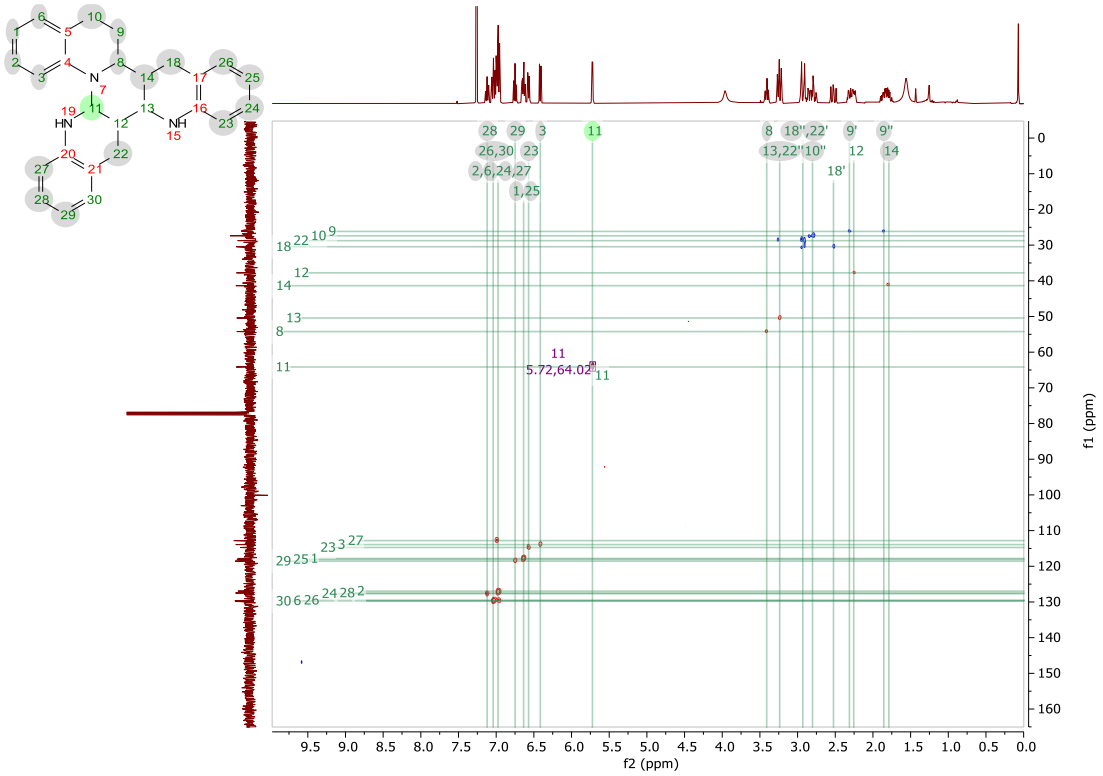
Spectrum 47 The ^{1}H NMR of **26**.



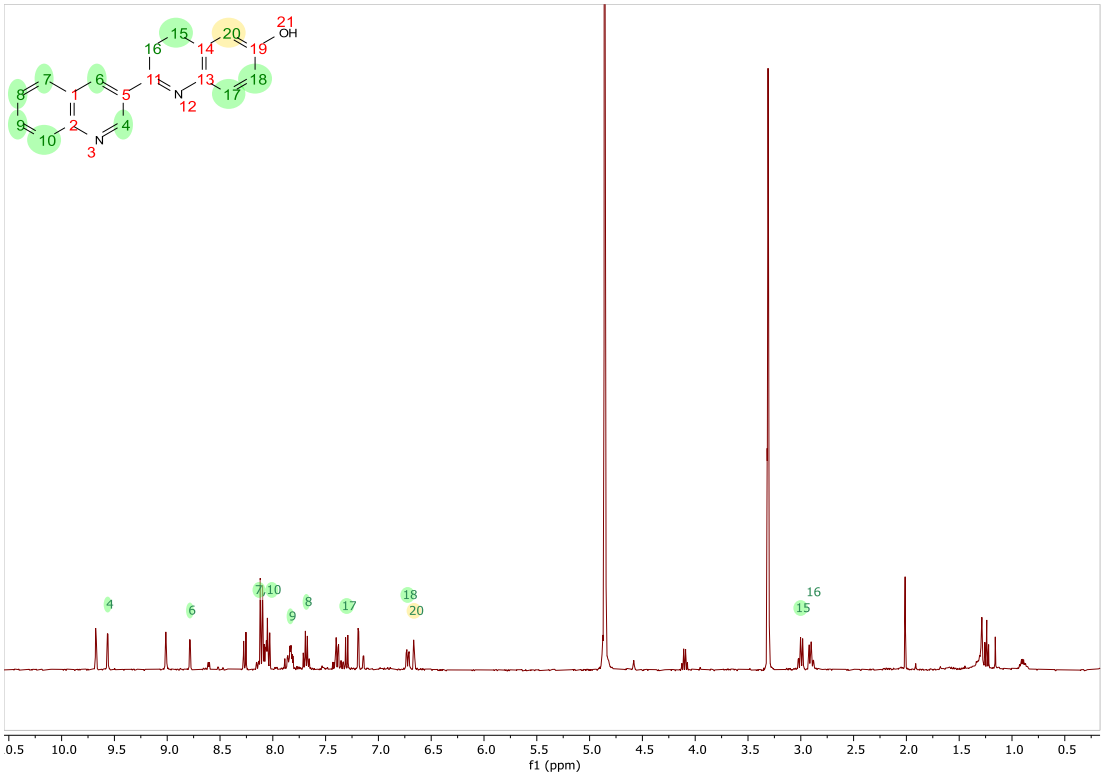
Spectrum 48 The DEPT NMR of **26**.



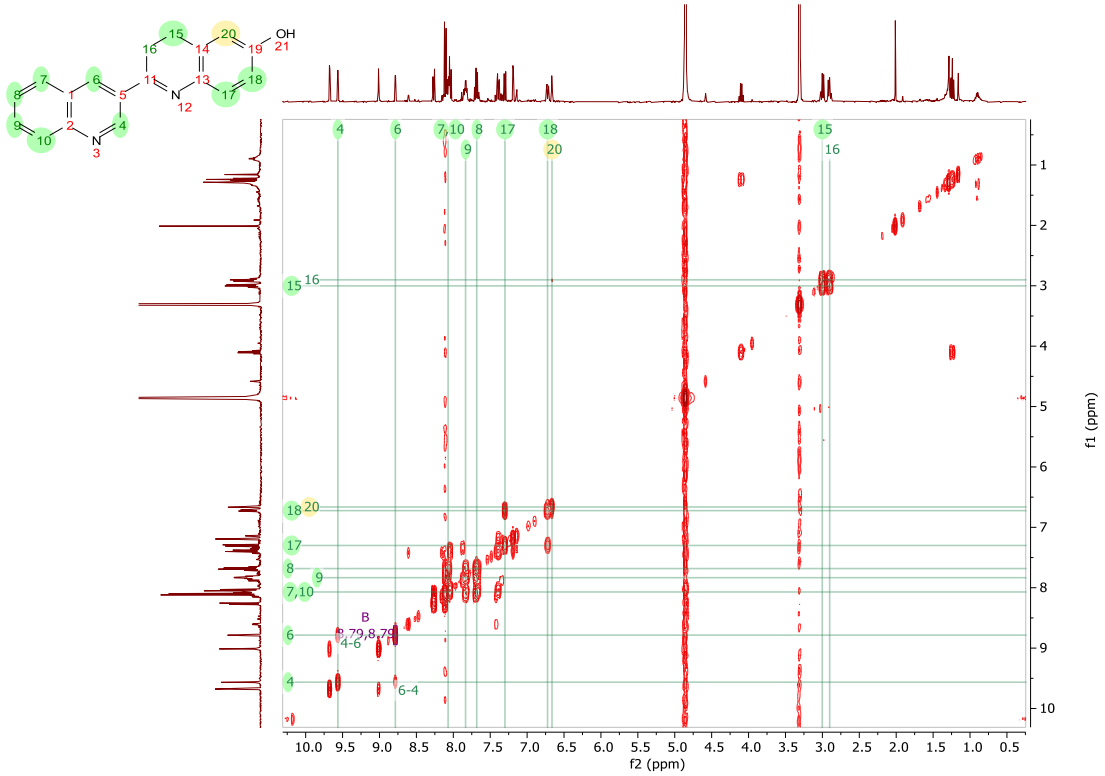
Spectrum 49 The COSY NMR of **26**.



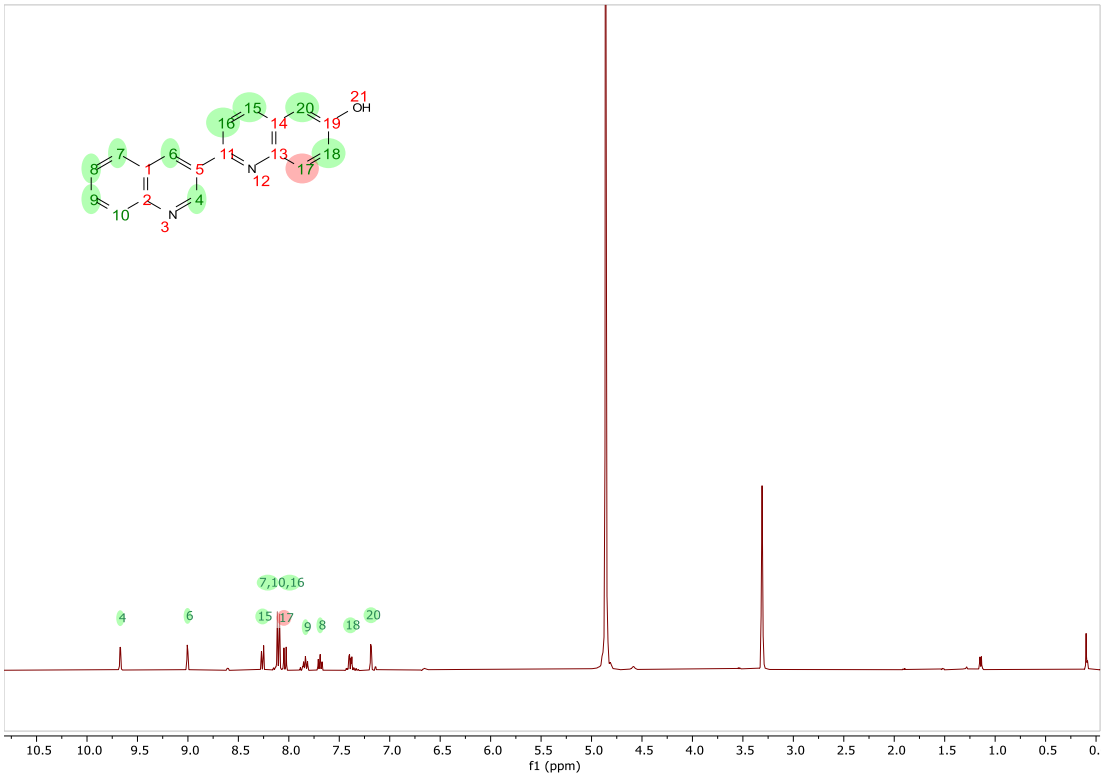
Spectrum 50 The HSQC NMR of **26**.



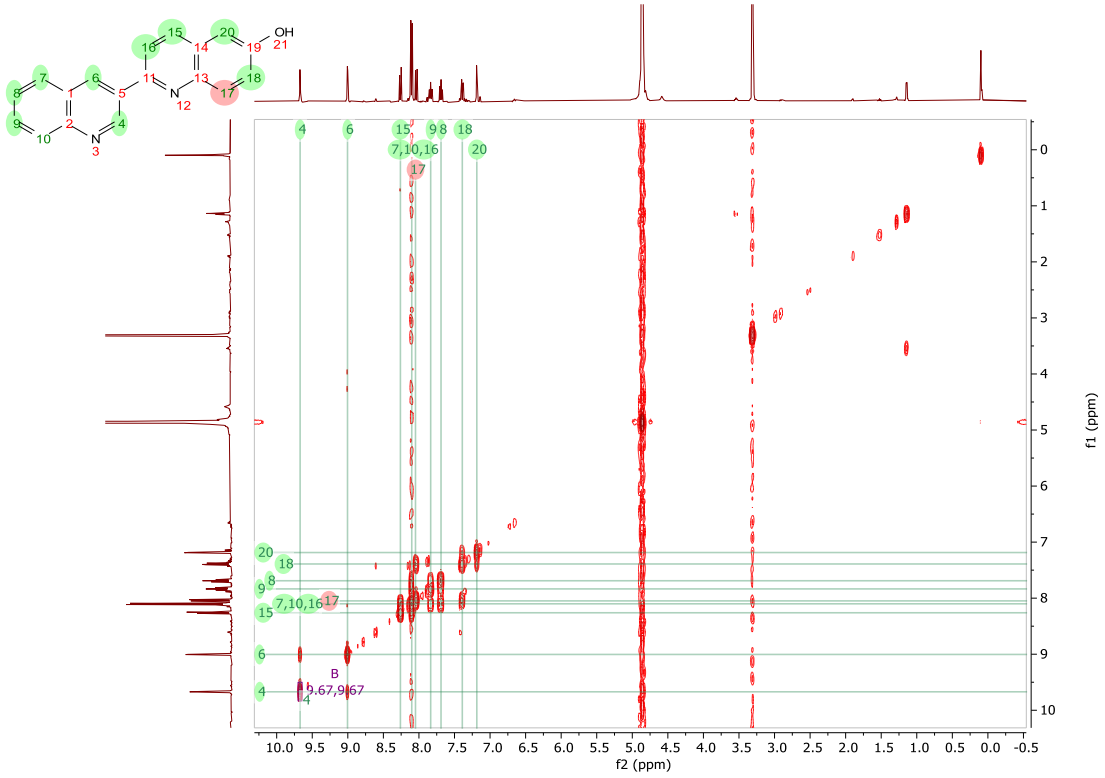
Spectrum 51 The ^{1}H NMR of the 1 : 0.9 mixture of **31** and **29** with **29** assigned.



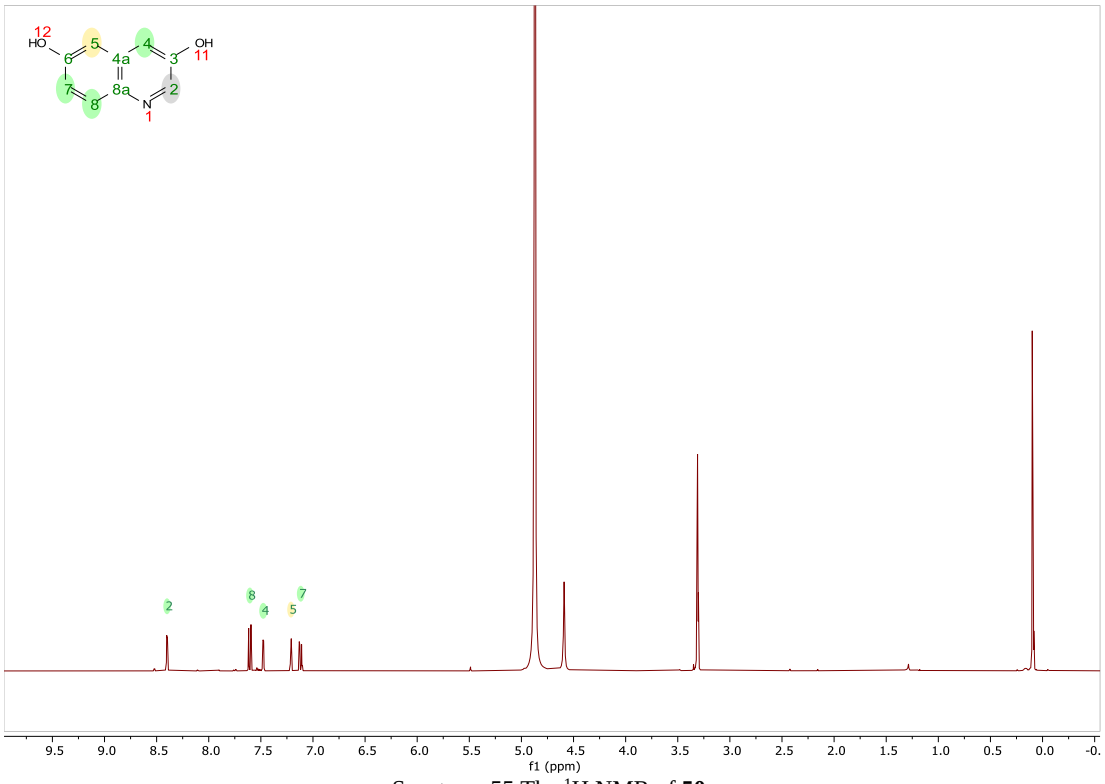
Spectrum 52 The COSY NMR of the 1 : 0.9 mixture of **31** and **29** with **29** assigned.



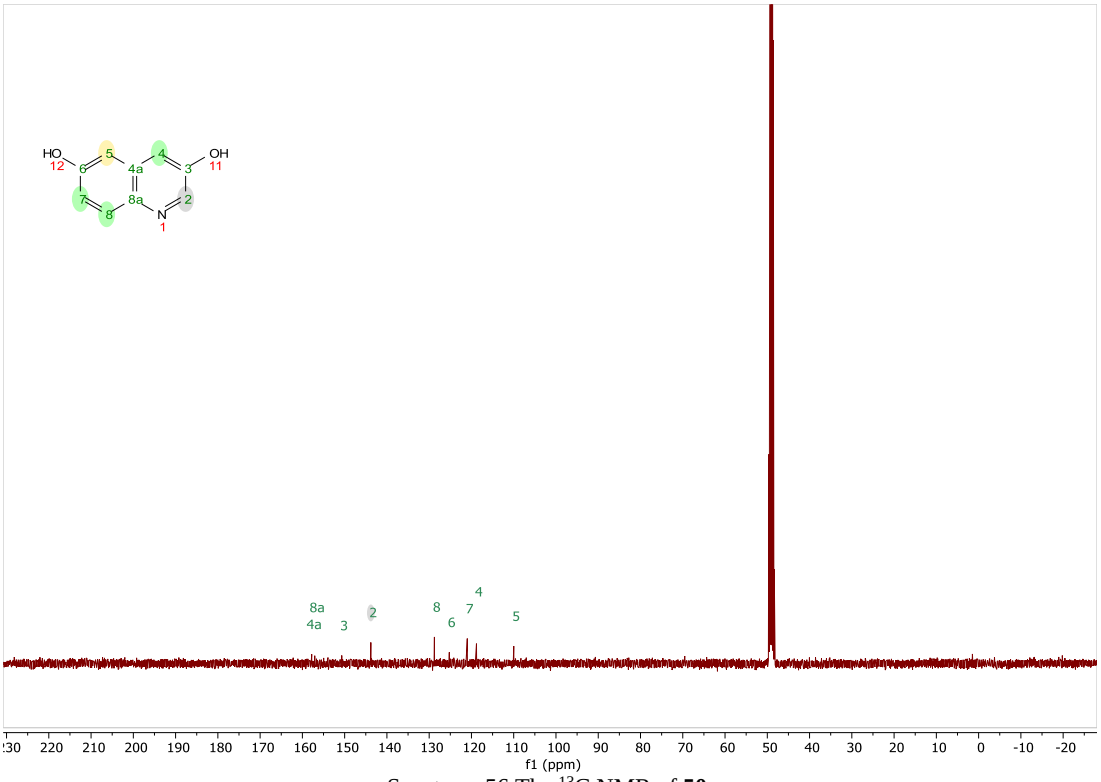
Spectrum 53 The ^{1}H NMR of **31**.



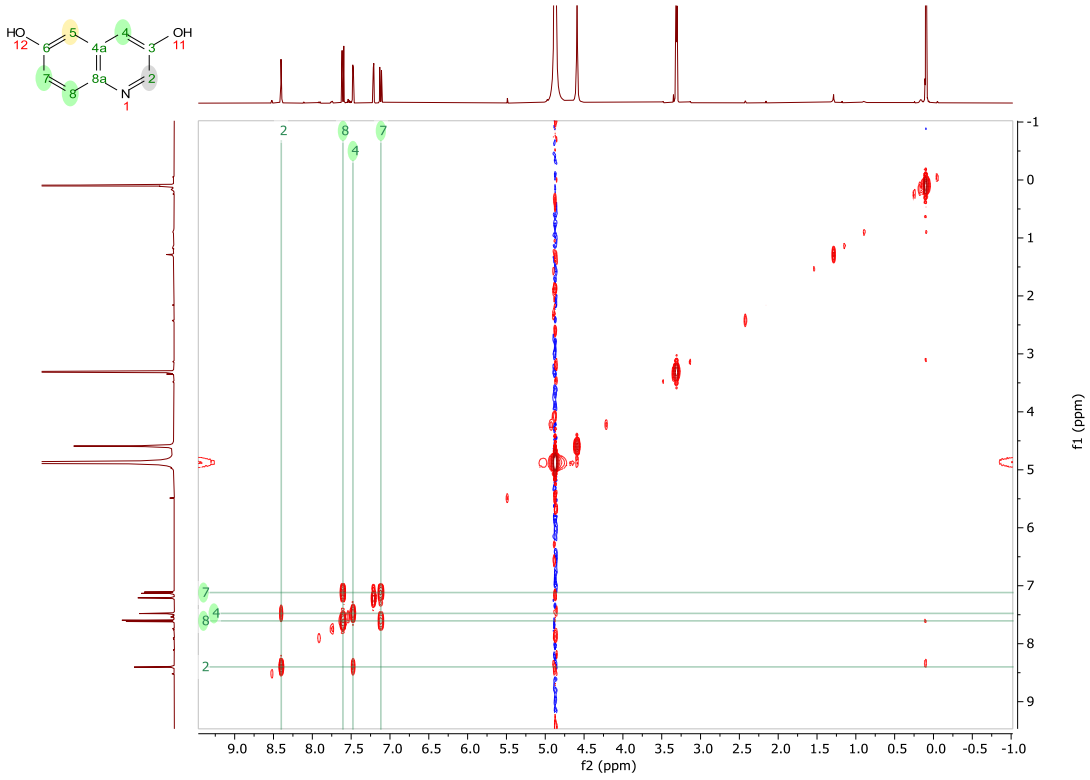
Spectrum 54 The COSY NMR of **31**.



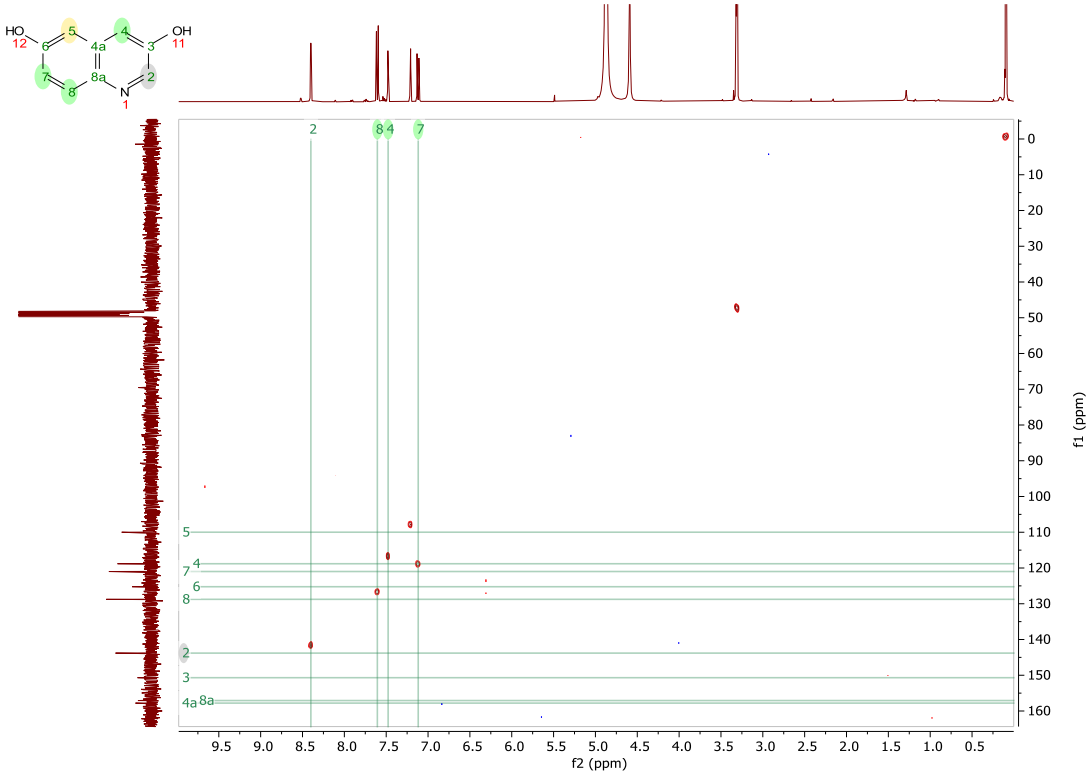
Spectrum 55 The ^{1}H NMR of **50**.



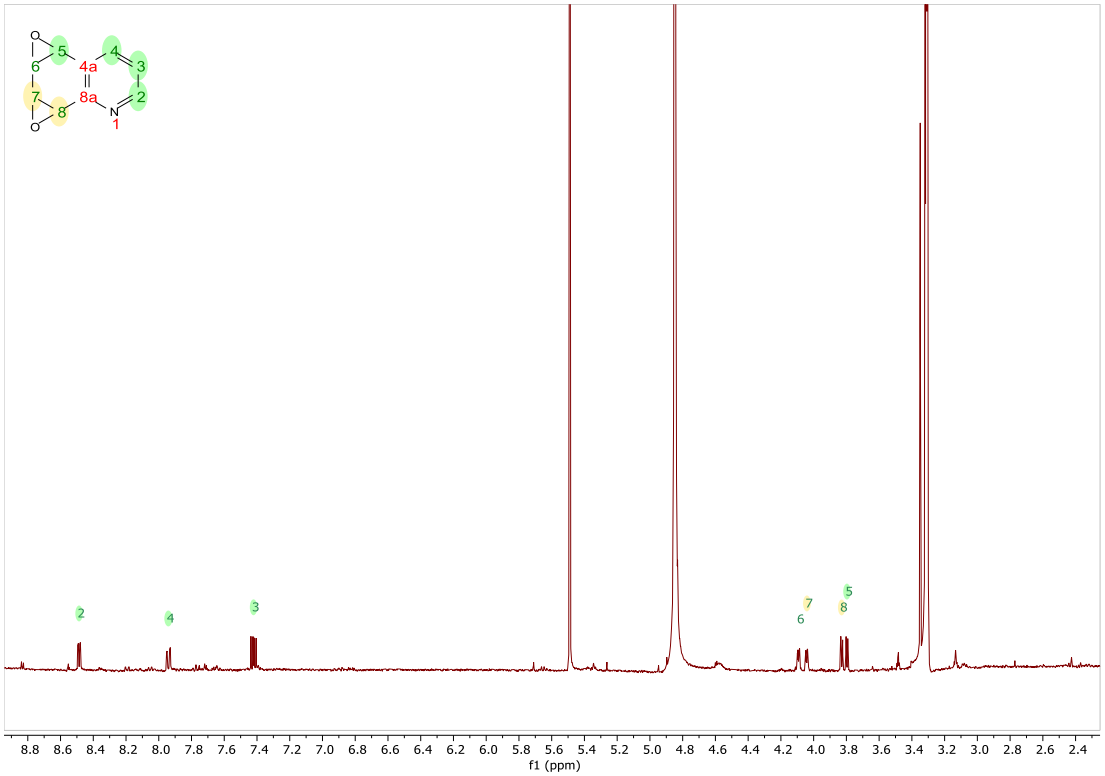
Spectrum 56 The ^{13}C NMR of **50**.



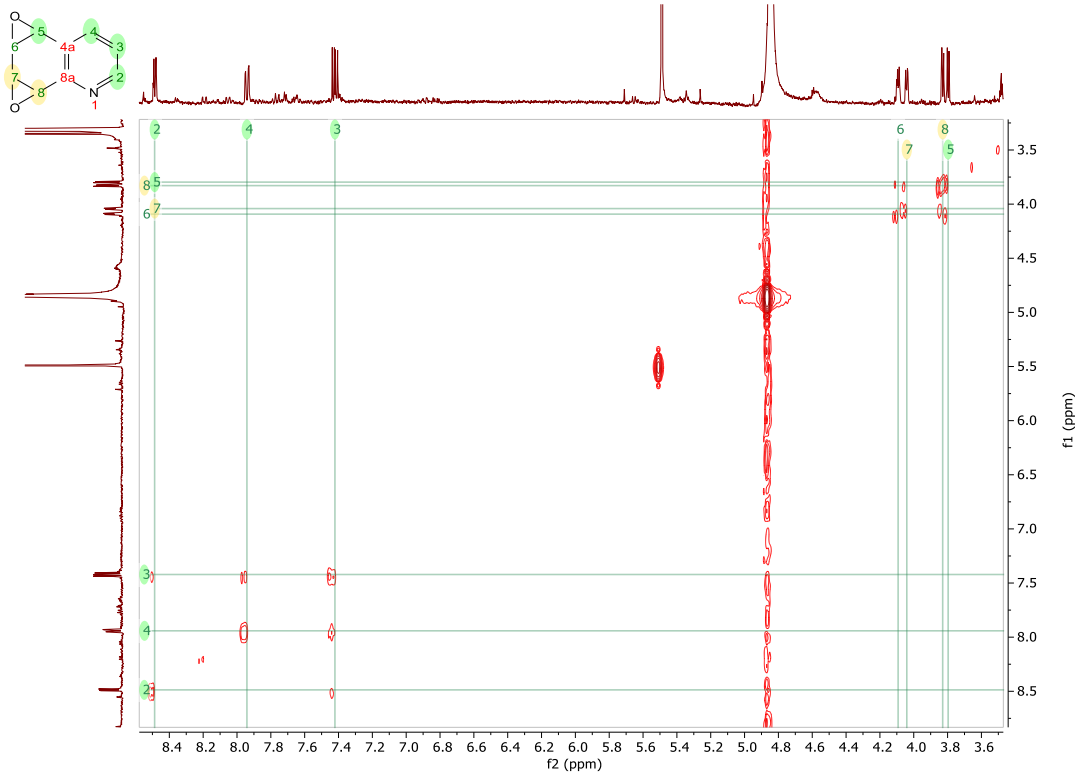
Spectrum 57 The COSY NMR of **50**.



Spectrum 58 The HSQC NMR of **50**.

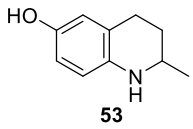


Spectrum 59 The ^{1}H NMR of **51**.



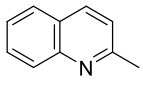
Spectrum 60 The COSY NMR of **51**.

Appendix 4.3 The NMR and MS data of the products in Chapter 5.



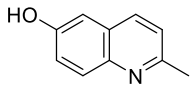
53

The title compound (**53**)[26] was obtained as a transparent oil (6.0 mg, 18% yield) using the described general method [from **52** (0.20 mmol) and the variant R19/I263G/A328L (0.10 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (500 MHz, CD_3OD) δ 6.50–6.46 (m, 1H), 6.44 (dd, *J* = 6.0 Hz, 1.8 Hz, 1H), 6.43 (d, *J* = 1.0 Hz, 1H), 3.24–3.16 (m, 1H), 2.84–2.74 (m, 1H), 2.65 (ddd, *J* = 16.7 Hz, 5.7 Hz, 3.0 Hz, 1H), 1.90 (ddt, *J* = 12.9 Hz, 6.0 Hz, 2.8 Hz, 1H), 1.52 (dddd, *J* = 13.0 Hz, 11.5 Hz, 10.2 Hz, 5.7 Hz, 1H), 1.18 (d, *J* = 6.3 Hz, 3H) ppm. ^{13}C NMR (125 MHz, CD_3OD) δ = 150.7, 139.0, 124.9, 118.0, 116.5, 114.7, 31.6, 27.7, 22.2 ppm. HRMS (ESI^+) calc. for $C_{10}H_{14}NO$ $[MH]^+$ 164.1070, found 164.1070.



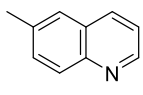
54

The title compound (**54**)[27] was obtained as a yellow oil (13.0 mg, 45% yield) using the described general method [from **52** (0.20 mmol) and the variant K19/A82M/F87A/E267F (0.10 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (400 MHz, CD_3OD) δ 8.16 (dd, *J* = 8.4 Hz, 0.8 Hz, 1H), 7.92 (dq, *J* = 8.4 Hz, 0.9 Hz, 1H), 7.83 (dd, *J* = 8.1 Hz, 1.4 Hz, 1H), 7.69 (ddd, *J* = 8.4 Hz, 6.9 Hz, 1.5 Hz, 1H), 7.50 (ddd, *J* = 8.1 Hz, 6.9 Hz, 1.2 Hz, 1H), 7.35 (d, *J* = 8.5 Hz, 1H), 2.68 (s, 3H) ppm. ^{13}C NMR (101 MHz, CD_3OD) δ 160.4, 148.3, 138.4, 131.0, 128.9, 128.2, 128.0, 127.1, 123.3, 24.6 ppm. HRMS (ESI^+) calc. for $C_{10}H_{10}N$ $[MH]^+$ 144.0808, found 144.0806.



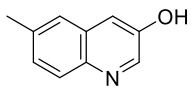
55

The title compound (**55**)[28] was obtained as a white solid (9.7 mg, 30% yield) using the described general method [from **53** (0.20 mmol) and the variant R19/I263G/A328L (0.10 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (500 MHz, CD_3OD) δ 8.02 (d, *J* = 8.5 Hz, 1H), 7.80 (d, *J* = 9.1 Hz, 1H), 7.31 (d, *J* = 8.5 Hz, 1H), 7.29 (dd, *J* = 9.1 Hz, 2.7 Hz, 1H), 7.10 (d, *J* = 2.7 Hz, 1H), 2.65 (s, 3H) ppm. ^{13}C NMR (125 MHz, CD_3OD) δ 157.0, 156.7, 143.6, 136.9, 129.5, 129.4, 123.4, 123.1, 109.6, 24.2 ppm. HRMS (ESI^+) calc. for $C_{10}H_{10}NO$ $[MH]^+$ 160.0757, found 160.0756.



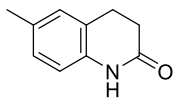
57

The title compound (**57**)[29] was obtained as a colourless oil (5.4 mg, 18% yield) using the described general method [from **56** (0.20 mmol) and the variant K19/F87V/Q403P (0.10 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (400 MHz, MeOD) δ 8.76 (dd, *J* = 4.3, 1.7 Hz, 1H), 8.27 (dt, *J* = 8.4, 1.3 Hz, 1H), 7.92 (d, *J* = 8.2 Hz, 1H), 7.72 (dt, *J* = 1.9, 1.0 Hz, 1H), 7.63 (dd, *J* = 8.6, 2.0 Hz, 1H), 7.49 (dd, *J* = 8.3, 4.4 Hz, 1H), 2.55 (d, *J* = 1.0 Hz, 3H) ppm. HRMS (ESI^+) calc. for $C_{10}H_{10}N$ $[MH]^+$ 144.0808, found 144.0807.



58

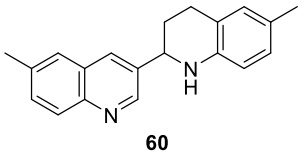
The title compound (**58**)[30] was obtained as a white solid (3.0 mg, 10% yield) using the described general method [from **56** (0.20 mmol) and the variant K19/V78I/F87V/E267V (0.10 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (400 MHz, MeOD) δ 8.43 (d, *J* = 2.7 Hz, 1H), 7.79 (d, *J* = 8.6 Hz, 1H), 7.51 (dd, *J* = 2.1, 1.1 Hz, 1H), 7.44 (dd, *J* = 2.8, 0.8 Hz, 1H), 7.38 (dd, *J* = 8.7, 1.9 Hz, 1H), 2.49 (d, *J* = 1.0 Hz, 4H) ppm. HRMS (ESI^+) calc. for $C_{10}H_{10}NO$ $[MH]^+$ 160.0757, found 160.0756.



59

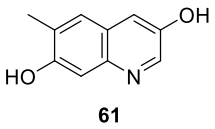
The title compound (**59**)[31] was obtained as a white solid (0.4 mg, 1% yield) using the described general method [from **56** (0.20 mmol) and the variant K19/V78I/F87V/E267V (0.10 μmol) in phosphate buffer, 20.0 mL reaction

volume] and purification by silica gel chromatography. ^{1}H NMR (400 MHz, MeOD) δ 7.00 (s, 1H), 6.97 (d, *J* = 8.6 Hz, 1H), 6.74 (d, *J* = 8.0 Hz, 1H), 2.93–2.87 (m, 2H), 2.56–2.51 (m, 2H), 2.27 (s, 3H) ppm. HRMS (ESI$^+$) calc. for $C_{10}H_{11}NO$ [MH]$^+$ 161.0841, found 161.0838.



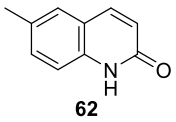
60

The title compound (**60**)[32] was obtained as a colourless oil (5.4 mg, 18% yield) using the described general method [from **56** (0.20 mmol) and the variant K19/V78I/F87V/E267V (0.10 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (400 MHz, MeOD) δ 8.80 (d, *J* = 2.2 Hz, 1H), 8.21 (dd, *J* = 2.1, 1.0 Hz, 1H), 7.90 (d, *J* = 8.4 Hz, 1H), 7.67 (dt, *J* = 1.8, 0.9 Hz, 1H), 7.59 (dd, *J* = 8.7, 2.0 Hz, 1H), 6.81–6.76 (m, 2H), 6.57 (d, *J* = 7.9 Hz, 1H), 4.62 (dd, *J* = 8.7, 3.3 Hz, 1H), 2.89 (ddd, *J* = 15.7, 9.6, 5.5 Hz, 1H), 2.64 (dt, *J* = 16.4, 5.3 Hz, 1H), 2.53 (d, *J* = 1.0 Hz, 3H), 2.23–2.14 (m, 4H), 2.06 (dddd, *J* = 12.9, 9.6, 8.6, 5.2 Hz, 1H) ppm. HRMS (ESI$^+$) calc. for $C_{20}H_{21}N_2$ [MH]$^+$ 289.1699, found 289.1696.



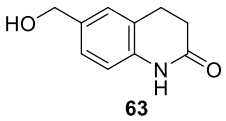
61

The title compound (**61**) was obtained as a white solid (1.2 mg, 40% yield) using the described general method [from **58** (0.02 mmol) and the variant K19/F87V/Q403P (0.05 μmol) in phosphate buffer, 10.0 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (400 MHz, MeOD) δ 8.32 (d, *J* = 2.8 Hz, 1H), 7.44 (d, *J* = 1.2 Hz, 1H), 7.40 (dd, *J* = 2.8, 0.8 Hz, 1H), 7.17 (s, 1H), 2.35 (d, *J* = 1.1 Hz, 4H) ppm. HRMS (ESI$^+$) calc. for $C_{10}H_{10}NO_2$ [MH]$^+$ 176.0706, found 176.0706.



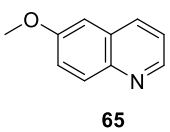
62

The title compound (**62**)[33] was obtained as a white solid (0.3 mg, 1% yield) using the described general method [from **56** (0.20 mmol) and the variant K19/V78I/F87V/E267V (0.10 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (400 MHz, MeOD) δ 7.91 (d, *J* = 9.4 Hz, 1H), 7.47 (d, *J* = 1.8 Hz, 1H), 7.40 (dd, *J* = 8.5, 2.0 Hz, 1H), 7.27 (d, *J* = 8.4 Hz, 1H), 6.59 (d, *J* = 9.5 Hz, 1H), 2.41 (s, 3H) ppm. HRMS (ESI$^+$) calc. for $C_{10}H_9NO$ [MH]$^+$ 160.0757, found 160.0758.



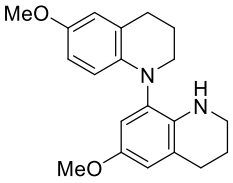
63

The title compound (**63**)[34] was obtained as a white solid (0.3 mg, 1% yield) using the described general method [from **56** (0.20 mmol) and the variant K19/V78I/F87V/E267V (0.10 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (400 MHz, MeOD) δ 7.08 (s, 1H), 7.05 (d, *J* = 8.1 Hz, 1H), 6.74 (d, *J* = 8.0 Hz, 1H), 4.43 (s, 2H), 2.85 (t, *J* = 7.6 Hz, 2H), 2.48–2.43 (m, 2H) ppm. HRMS (ESI$^+$) calc. for $C_{10}H_{12}NO_2$ [MH]$^+$ 178.0863, found 178.1.



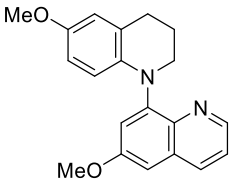
65

The title compound (**65**)[35] was obtained as a white solid (12.1 mg, 37% yield) using the described general method [from **64** (0.20 mmol) and the variant R19/F87A/A328G/P329G/A330G (0.10 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.76 (dd, *J* = 4.2, 1.7 Hz, 1H), 8.03 (dd, *J* = 8.4, 1.3 Hz, 1H), 7.99 (d, *J* = 9.2 Hz, 1H), 7.43–7.27 (m, 2H), 7.06 (d, *J* = 2.8 Hz, 1H), 3.92 (s, 3H) ppm. ^{13}C NMR (101 MHz, $CDCl_3$) δ 157.71, 147.96, 144.45, 134.76, 130.88, 129.29, 122.27, 121.36, 105.10, 55.53 ppm. HRMS (ESI$^+$) calc. for $C_{10}H_{10}NO$ [MH]$^+$ 160.0757, found 160.0759.



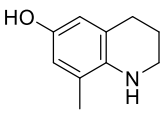
66

The title compound (**66**) was obtained as a white solid (6.3 mg, 19% yield) using the described general method [from **64** (0.20 mmol) and the variant I263G (0.10 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (500 MHz, $CDCl_3$) δ 6.62 (d, *J* = 2.9 Hz, 1H), 6.55–6.49 (m, 3H), 6.22 (d, *J* = 8.9 Hz, 1H), 4.07 (s, 1H), 3.72 (s, 3H), 3.69 (s, 3H), 3.40 (t, *J* = 5.4 Hz, 2H), 3.23 (br s, 2H), 3.04–2.72 (m, 4H), 2.06 (dt, *J* = 10.9, 5.4 Hz, 2H), 1.95 (p, *J* = 6.1 Hz, 2H) ppm. HRMS (ESI$^+$) calc. for $C_{20}H_{25}N_2O_2$ $[MH]^+$ 325.1911, found 325.2.



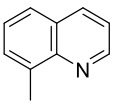
67

The title compound (**67**) was obtained as a white solid (1.8 mg, 6% yield) using the described general method [from **64** (0.20 mmol) and the variant R19/F87A/A328G/P329G/A330G (0.10 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (500 MHz, $CDCl_3$) δ 8.77 (dd, *J* = 4.2, 1.7 Hz, 1H), 8.04 (dd, *J* = 8.2, 1.8 Hz, 1H), 7.35 (dd, *J* = 8.3, 4.1 Hz, 1H), 7.08 (d, *J* = 2.8 Hz, 1H), 6.85 (d, *J* = 2.8 Hz, 1H), 6.65 (d, *J* = 2.9 Hz, 1H), 6.57 (d, *J* = 9.0 Hz, 1H), 6.51 (dd, *J* = 8.9, 2.9 Hz, 1H), 3.88 (s, 3H), 3.86–3.82 (m, 2H), 3.75 (s, 3H), 2.91 (t, *J* = 6.6 Hz, 2H), 1.96 (dq, *J* = 11.6, 5.9 Hz, 2H) ppm. HRMS (ESI$^+$) calc. for $C_{20}H_{21}N_2O_2$ $[MH]^+$ 321.1598, found 321.1.



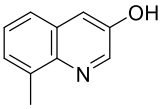
71

The title compound (**71**)[12] was obtained as a white solid (8.4 mg, 26% yield) using the described general method [from **70** (0.20 mmol) and the variant R19/I263G/A328L (0.10 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (500 MHz, CD_3OD) δ 6.37 (d, *J* = 2.7 Hz, 1H), 6.30 (d, *J* = 2.8 Hz, 1H), 3.25–3.19 (m, 2H), 2.69 (t, *J* = 6.5 Hz, 2H), 2.05 (s, 3H), 1.92–1.84 (m, 2H) ppm. ^{13}C NMR (125 MHz, CD_3OD) δ 148.6, 135.3, 124.6, 123.4, 114.8, 113.2, 42.4, 27.0, 22.2, 16.1 ppm. HRMS (ESI$^+$) calc. for $C_{10}H_{14}NO$ $[MH]^+$ 164.1070, found 164.1071.



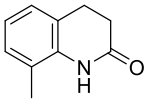
72

The title compound (**72**)[36] was obtained as a yellow oil (12.0 mg, 42% yield) using the described general method [from **70** (0.20 mmol) and the variant K19/V78I/F87V/E267V (0.10 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (400 MHz, CD_3OD) δ 8.82 (dd, *J* = 4.3 Hz, 1.8 Hz, 1H), 8.24 (dd, *J* = 8.3 Hz, 1.8 Hz, 1H), 7.73–7.67 (m, 1H), 7.56 (dp, *J* = 7.0 Hz, 1.1 Hz, 1H), 7.48–7.40 (m, 2H), 2.73 (d, *J* = 0.7 Hz, 3H) ppm. ^{13}C NMR (101 MHz, CD_3OD) δ 150.2, 148.0, 138.3, 137.4, 131.1, 129.9, 127.6, 127.3, 122.1, 18.3 (d, *J* = 2.3 Hz) ppm. HRMS (ESI$^+$) calc. for $C_{10}H_{10}N$ $[MH]^+$ 144.0808, found 144.0807.



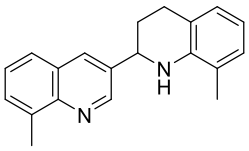
73

The title compound (**73**)[37] was obtained as a white solid (4.0 mg, 13% yield) using the described general method [from **72** (0.20 mmol) and the variant R19/I263A/A328L (0.10 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (500 MHz, CD_3OD) δ 8.55 (d, *J* = 2.8 Hz, 1H), 7.59 (dd, *J* = 5.7 Hz, 3.9 Hz, 1H), 7.50 (d, *J* = 2.8 Hz, 1H), 7.41–7.36 (m, 2H), 2.73 (s, 3H) ppm. ^{13}C NMR (125 MHz, CD_3OD) δ 151.0, 142.0, 141.5, 135.8, 129.7, 126.6, 126.5, 124.5, 116.6, 17.0 ppm; HRMS (ESI$^+$) calc. for $C_{10}H_{10}NO$ $[MH]^+$ 160.0757, found 160.0756.



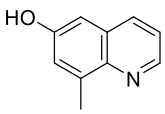
74

The title compound (**74**)[38] was obtained as a light yellow solid (2.4 mg, 7% yield) using the described general method [from **70** (0.20 mmol) and the variant K19/F87V (0.10 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (500 MHz, CD_3OD) δ 7.62 (dd, *J* = 8.0 Hz, 1.5 Hz, 1H), 7.21 (dt, *J* = 7.4 Hz, 1.2 Hz, 1H), 6.59 (dd, *J* = 8.1 Hz, 7.1 Hz, 1H), 3.60–3.55 (m, 2H), 2.66–2.61 (m, 2H), 2.17 (s, 3H) ppm. ^{13}C NMR (125 MHz, CD_3OD) δ 195.8, 151.6, 135.5, 129.2, 124.7, 117.8, 116.0, 41.2, 37.2, 15.7 ppm. HRMS (ESI^+) calc. for $C_{10}H_{12}NO$ $[MH]^+$ 162.0913, found 162.0914.



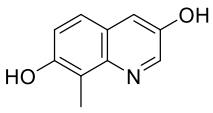
75

The title compound (**75**)[12] was obtained as a transparent oil (15.0 mg, 52% yield) using the described general method [from **70** (0.20 mmol) and the variant K19/A82M/F87A (0.10 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography (petrol/EtOAc, 8:1). Substrate conversion was 0.40% after 18 h. R_f = 0.40 (petrol/EtOAc, 9:1); ^{1}H NMR (500 MHz, CD_3OD) δ 8.81 (d, *J* = 2.3 Hz, 1H), 8.13 (d, *J* = 2.2 Hz, 1H), 7.63 (d, *J*=8.3, 1H), 7.47 (dt, *J* = 7.0 Hz, 1.3 Hz, 1H), 7.36 (dd, *J* = 8.2 Hz, 7.0 Hz, 1H), 6.79 (d, *J* = 7.5 Hz, 1H), 6.72 (d, *J* = 7.2 Hz, 1H), 6.43 (t, *J* = 7.5 Hz, 1H), 4.72 (dd, *J* = 7.8 Hz, 3.7 Hz, 1H), 2.84–2.76 (m, 1H), 2.66 (s, 3H), 2.55 (dt, *J* = 16.3 Hz, 6.0 Hz, 1H), 2.13 (dddd, *J* = 11.9 Hz, 6.8 Hz, 5.1 Hz, 3.7 Hz, 1H), 2.07 (s, 3H), 2.05–1.97 (m, 1H) ppm. ^{13}C NMR (125 MHz, CD_3OD) δ 148.7, 145.9, 142.3, 138.3, 135.8, 133.9, 129.4, 128.3, 127.7, 126.6, 126.4, 125.9, 121.4, 120.0, 116.4, 53.5, 30.0, 25.2, 17.0, 16.2 ppm. HRMS (ESI^+) calc. for $C_{20}H_{21}N_2$ $[MH]^+$ 289.1699, found 289.1696.



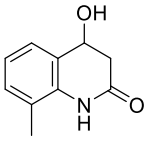
76

The title compound (**76**)[12] was obtained as a white solid (0.3 mg, 1% yield) using the described general method [from **71** (0.10 mmol) and the variant R19/I263G/A328L (0.10 μmol) in phosphate buffer, 10.0 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (500 MHz, CD_3OD) δ 8.52 (dd, *J* = 4.3 Hz, 1.7 Hz, 1H), 7.98 (dd, *J* = 8.3 Hz, 1.7 Hz, 1H), 7.30 (dd, *J* = 8.3 Hz, 4.2 Hz, 1H), 7.10 (dd, *J* = 2.6 Hz, 1.1 Hz, 1H), 6.87 (d, *J* = 2.7 Hz, 1H), 2.60 (s, 3H) ppm; HRMS (ESI^+) calc. for $C_{10}H_{10}NO$ $[MH]^+$ 160.0757, found 160.0759.



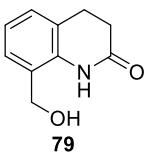
77

The title compound (**77**) was obtained as a white solid (3.2 mg, 80% yield) using the described general method [from **73** (0.025 mmol) and the variant R19/I263G/A328L (0.25 μmol) in phosphate buffer, 5.0 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (400 MHz, MeOD) δ 8.46 (d, *J* = 2.9 Hz, 1H), 7.47–7.36 (m, 2H), 7.13 (d, *J* = 8.8 Hz, 1H), 2.53 (s, 3H) ppm. HRMS (ESI^+) calc. for $C_{10}H_{10}NO_2$ $[MH]^+$ 176.0706, found 176.0709.



78

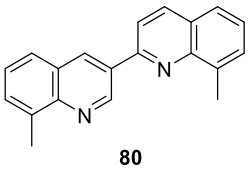
The title compound (**78**) was obtained as a white solid (0.4 mg, 1% yield) using the described general method [from **70** (0.20 mmol) and the variant GV/A184I (0.10 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (400 MHz, MeOD) δ 7.21 (d, *J* = 7.6 Hz, 1H), 7.13 (d, *J* = 7.4 Hz, 1H), 6.97 (t, *J* = 7.5 Hz, 1H), 4.83 (d, *J* = 4.7 Hz, 1H), 2.75 (qd, *J* = 16.3, 4.7 Hz, 2H), 2.27 (s, 3H) ppm. HRMS (ESI^+) calc. for $C_{10}H_{12}NO_2$ $[MH]^+$ 178.0863, found 178.1.



79

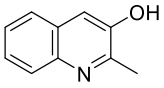
The title compound (**79**) was obtained as a white solid (0.2 mg, 1% yield) using the described general method [from **70** (0.20 mmol) and the variant GV/A184I (0.10 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (400 MHz, MeOD) δ 7.17 (d, *J* = 7.5 Hz,

1H), 7.10 (d, *J* = 7.4 Hz, 1H), 6.96 (t, *J* = 7.6 Hz, 1H), 4.68 (s, 2H), 2.97 (t, *J* = 7.5 Hz, 2H), 2.59 (t, *J* = 8.0, 6.8 Hz, 2H) ppm. HRMS (ESI$^+$) calc. for $C_{10}H_{12}NO_2$ $[MH]^+$ 178.0863, found 178.1.



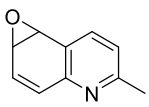
80

The title compound (**80**) was obtained as a colourless oil (2.3 mg, 8% yield) using the described general method [from **70** (0.20 mmol) and the variant K19/F87V (0.10 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (400 MHz, C_6D_6) δ 10.13 (d, *J* = 2.3 Hz, 1H), 8.63 (d, *J* = 2.3 Hz, 1H), 7.67 (d, *J* = 8.5 Hz, 1H), 7.53 (dd, *J* = 8.0, 1.5 Hz, 1H), 7.46 (d, *J* = 8.5 Hz, 1H), 7.39 (dd, *J* = 8.2, 1.5 Hz, 1H), 7.36 (dt, *J* = 7.1, 1.2 Hz, 2H), 7.24 (dd, *J* = 8.2, 7.0 Hz, 1H), 7.21–7.18 (m, 1H), 3.02 (s, 3H), 2.91 (s, 3H) ppm. HRMS (ESI$^+$) calc. for $C_{20}H_{17}N_2$ $[MH]^+$ 285.1386, found 285.1.



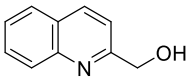
81

The title compound (**81**)[39] was obtained as a white solid (1.5 mg, 5% yield) using the described general method [from **54** (0.20 mmol) and the variant RT2/V78I/A184I/A330P (0.10 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (500 MHz, CD_3OD) δ 7.89–7.86 (m, 1H), 7.70 (dd, *J* = 8.0 Hz, 1.5 Hz, 1H), 7.51 (ddd, *J* = 8.5 Hz, 6.9 Hz, 1.6 Hz, 1H), 7.48–7.45 (m, 1H), 7.44 (s, 1H), 2.63 (s, 3H) ppm. ^{13}C NMR (125 MHz, CD_3OD) δ 152.4, 141.6, 129.0, 127.4, 126.5, 125.9, 125.9, 125.7, 115.0, 18.4 ppm. HRMS (ESI$^+$) calc. for $C_{10}H_{10}NO$ $[MH]^+$ 160.0757, found 160.0756.



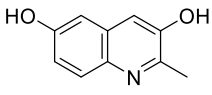
82

The title compound (**82**)[12] was obtained as a transparent oil (12 mg, 38% yield) using the described general method [from **54** (0.20 mmol) and the variant RP/H171L/I263G (0.10 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (500 MHz, CD_3OD) δ 8.01 (dd, *J* = 7.9 Hz, 0.7 Hz, 1H), 7.28 (d, *J* = 7.8 Hz, 1H), 6.88 (ddd, *J* = 9.9 Hz, 1.7 Hz, 0.7 Hz, 1H), 6.81 (dd, *J* = 9.9 Hz, 3.8 Hz, 1H), 4.58 (d, *J* = 3.8 Hz, 1H), 4.19 (td, *J* = 3.8 Hz, 1.7 Hz, 1H), 2.58 (s, 3H) ppm. ^{13}C NMR (125 MHz, CD_3OD) δ 158.2, 150.0, 138.3, 131.4, 131.1, 126.3, 122.3, 55.9, 52.6, 22.4 ppm. HRMS (ESI$^+$) calc. for $C_{10}H_{10}NO$ $[MH]^+$ 160.0757, found 160.0757.



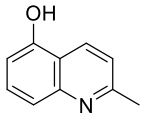
83

The title compound (**83**)[40] was obtained as a white solid (10 mg, 31% yield) using the described general method [from **54** (0.20 mmol) and the variant R19/F87A/A328I (0.10 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (400 MHz, CD_3OD) δ 8.36 (dd, *J* = 8.6 Hz, 0.8 Hz, 1H), 8.00 (dq, *J* = 8.5 Hz, 0.9 Hz, 1H), 7.93 (dd, *J* = 8.1 Hz, 1.4 Hz, 1H), 7.75 (ddd, *J* = 8.4 Hz, 6.9 Hz, 1.5 Hz, 1H), 7.70 (d, *J* = 8.5 Hz, 1H), 7.58 (ddd, *J* = 8.1 Hz, 6.9 Hz, 1.2 Hz, 1H), 4.87 (s, 1H) ppm. ^{13}C NMR (101 MHz, CD_3OD) δ 163.0, 148.2, 138.8, 131.1, 129.0, 128.8, 127.6, 120.2, 66.1 ppm. HRMS (ESI$^+$) calc. for $C_{10}H_{10}NO$ $[MH]^+$ 160.0757, found 160.0757.



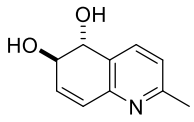
84

The title compound (**84**) was obtained as a white solid (1.2 mg, 4% yield) using the described general method [from **54** (0.20 mmol) and the variant RT2/V78I/A184I/A330P (0.10 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (400 MHz, MeOD) δ 7.52 (d, *J* = 8.8 Hz, 1H), 7.35 (s, 1H), 7.18 (dt, *J* = 2.4, 0.7 Hz, 1H), 7.03 (dd, *J* = 8.9, 2.4 Hz, 1H), 2.56 (s, 3H). HRMS (ESI$^+$) calc. for $C_{10}H_{10}NO_2$ $[MH]^+$ 176.0707, found 176.0706.



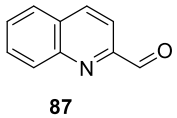
85

The title compound (**85**)[41] was obtained as a light yellow oil (4.5 mg, 15% yield) using the described general method [from **54** (0.20 mmol) and the variant RP/H171L/I263G (0.10 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (500 MHz, CD_3OD) δ 8.53 (d, *J* = 8.4 Hz, 1H), 7.50 (dd, *J* = 8.5 Hz, 7.6 Hz, 1H), 7.44–7.40 (m, 1H), 7.34 (d, *J* = 8.5 Hz, 1H), 6.84 (dd, *J* = 7.6 Hz, 0.9 Hz, 1H), 2.69 (s, 3H) ppm. ^{13}C NMR (125 MHz, CD_3OD) δ 160.3, 154.9, 149.5, 133.4, 131.4, 121.8, 119.8, 118.9, 109.1, 24.5 ppm; HRMS (ESI^+) calc. for $C_{10}H_{10}NO$ $[MH]^+$ 160.0757, found 160.0757.



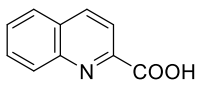
86

The title compound (**86**) was obtained as a transparent oil (0.8 mg, 3% yield) using the described general method [from **54** (0.20 mmol) and the variant RP/H171L/A184I/I263G (0.10 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (400 MHz, CD_3OD) δ 7.81 (d, *J* = 7.8 Hz, 1H), 7.14 (d, *J* = 7.8 Hz, 1H), 6.51 (ddd, *J* = 10.0, 2.2, 0.7 Hz, 1H), 6.26 (dd, *J* = 10.1, 2.5 Hz, 1H), 4.73 (d, *J* = 10.2 Hz, 1H), 4.57 (s, 2H), 4.39 (dt, *J* = 10.1, 2.4 Hz, 1H), 2.48 (s, 3H) ppm. HRMS (ESI^+) calc. for $C_{10}H_{12}NO_2$ $[MH]^+$ 178.0863, found 178.1.



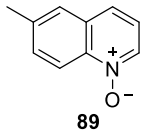
87

The title compound (**87**)[42] was obtained as a yellow oil (2.0 mg, 7% yield) using the described general method [from **54** (0.20 mmol) and the variant RP/H171L/A184I/I263G (0.10 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (500 MHz, $CDCl_3$) δ 10.20 (s, 1H), 8.26 (d, *J* = 8.4 Hz, 1H), 8.21 (d, *J* = 8.5 Hz, 1H), 7.98 (d, *J* = 8.4 Hz, 1H), 7.86 (d, *J* = 8.1 Hz, 1H), 7.79 (t, *J* = 7.2 Hz, 1H), 7.65 (t, *J* = 7.1 Hz, 1H) ppm. ^{13}C NMR (126 MHz, $CDCl_3$) δ 193.7, 152.6, 147.9, 137.4, 130.5, 130.4, 130.0, 129.2, 127.9, 117.3 ppm. HRMS (ESI^+) calc. for $C_{10}H_8NO$ $[MH]^+$ 158.0601, found 158.0593.



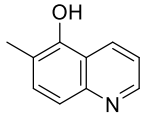
88

The title compound (**88**)[43] was obtained as a white solid (3.2 mg, 11% yield) using the described general method [from **54** (0.20 mmol) and the variant RP/H171L/A184I/I263G (0.10 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (400 MHz, CD_3OD) δ 8.38 (dd, *J* = 8.5, 0.7 Hz, 1H), 8.09–8.06 (m, 1H), 7.98–7.91 (m, 1H), 7.77 (ddd, *J* = 8.6, 6.9, 1.5 Hz, 1H), 7.74 (d, *J* = 8.5 Hz, 1H), 7.61 (ddd, *J* = 8.1, 6.9, 1.2 Hz, 1H) ppm. HRMS (ESI^+) calc. for $C_{10}H_8NO_2$ $[MH]^+$ 174.0550, found 174.0551.



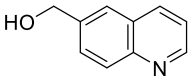
89

The title compound (**89**)[44] was obtained as a yellow solid (2.2 mg, 8% yield) using the described general method [from **57** (0.20 mmol) and the variant R19/F87A (0.10 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (400 MHz, CD_3OD) δ 8.61 (dd, *J* = 6.1, 1.1 Hz, 1H), 8.53 (d, *J* = 9.0 Hz, 1H), 8.08 (d, *J* = 8.4 Hz, 1H), 7.87 (d, *J* = 1.7 Hz, 1H), 7.77 (dd, *J* = 9.0, 2.2 Hz, 2H), 7.51 (dd, *J* = 8.4, 6.0 Hz, 1H), 2.59 (d, *J* = 0.5 Hz, 3H) ppm. HRMS (ESI^+) calc. for $C_{10}H_{10}NO$ $[MH]^+$ 160.0757, found 160.0756.



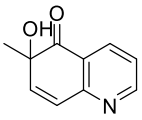
90

The title compound (**90**)[45] was obtained as a yellow solid (12.3 mg, 42% yield) using the described general method [from **57** (0.20 mmol) and the variant RT2/V78I/A184I/A330P (0.10 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (400 MHz, CD_3OD) δ 8.71 (dd, *J* = 4.3, 1.7 Hz, 1H), 8.66 (ddd, *J* = 8.5, 1.7, 0.7 Hz, 1H), 7.53 – 7.47 (m, 2H), 7.43 (dd, *J* = 8.5, 4.3 Hz, 1H), 2.41 (s, 3H) ppm. HRMS (ESI^+) calc. for $C_{10}H_{10}NO$ $[MH]^+$ 160.0757, found 160.0759.



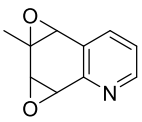
91

The title compound (**91**)[46] was obtained as a colourless oil (10.8 mg, 37% yield) using the described general method [from **57** (0.20 mmol) and the variant RP/H171L/I263G (0.10 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (400 MHz, CD_3OD) δ 8.81 (dd, *J* = 4.3, 1.7 Hz, 1H), 8.35 (ddd, *J* = 8.2, 1.8, 0.8 Hz, 1H), 8.01 (d, *J* = 8.7 Hz, 1H), 7.90 (dd, *J* = 2.0, 1.0 Hz, 1H), 7.78 (dd, *J* = 8.7, 2.0 Hz, 1H), 7.53 (dd, *J* = 8.3, 4.3 Hz, 1H), 4.83–4.80 (m, 2H) ppm. HRMS (ESI$^+$) calc. for $C_{10}H_{10}NO$ $[MH]^+$ 160.0757, found 160.0756.



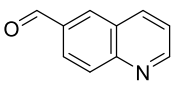
92

The title compound (**92**) was obtained as a colourless oil (0.8 mg, 3% yield) using the described general method [from **57** (0.20 mmol) and the variant R RT2/V78I/A184I/A330P (0.10 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (400 MHz, CD_3OD) δ 8.73 (dd, *J* = 5.0, 1.8 Hz, 1H), 8.30 (ddd, *J* = 7.8, 1.8, 0.7 Hz, 1H), 7.44 (dd, *J* = 7.8, 4.9 Hz, 1H), 6.70 (dd, *J* = 10.2, 0.7 Hz, 1H), 6.57 (d, *J* = 10.2 Hz, 1H), 4.57 (s, 1H), 1.43 (s, 3H) ppm. HRMS (ESI$^+$) calc. for $C_{10}H_{10}NO_2$ $[MH]^+$ 176.0707, found 176.0.



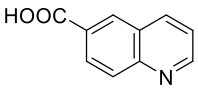
93

The title compound (**93**) was obtained as a colourless oil (1.2 mg, 4% yield) using the described general method [from **57** (0.20 mmol) and the variant R RT2/V78I/A184I/A330P (0.10 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (400 MHz, CD_3OD) δ 8.58 (dd, *J* = 5.0, 1.7 Hz, 1H), 8.14–8.07 (m, 1H), 7.50 (dd, *J* = 7.7, 4.9 Hz, 1H), 4.07 (dd, *J* = 3.6, 0.7 Hz, 1H), 3.98 (s, 1H), 3.80 (dd, *J* = 3.6, 0.6 Hz, 1H), 1.78 (s, 3H) ppm.HRMS (ESI$^+$) calc. for $C_{10}H_{10}NO_2$ $[MH]^+$ 176.0707, found 176.0.



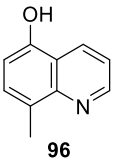
94

The title compound (**94**)[42] was obtained as a white solid (3.2 mg, 11% yield) using the described general method [from **57** (0.20 mmol) and the variant RP/H171L/I263G (0.10 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (400 MHz, CD_3OD) δ 10.19 (d, *J* = 0.7 Hz, 1H), 9.01 (dd, *J* = 4.4, 1.7 Hz, 1H), 8.62–8.55 (m, 2H), 8.23 (dd, *J* = 8.8, 1.8 Hz, 1H), 8.16 (dq, *J* = 8.8, 0.7 Hz, 1H), 7.67 (dd, *J* = 8.4, 4.4 Hz, 1H) ppm. HRMS (ESI$^+$) calc. for $C_{10}H_8NO$ $[MH]^+$ 158.0601, found 158.0592.



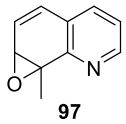
95

The title compound (**95**)[47] was obtained as a white solid (1.1 mg, 4% yield) using the described general method [from **57** (0.20 mmol) and the variant RP/H171L/I263G (0.10 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (400 MHz, CD_3OD) δ 8.84 (dd, *J* = 4.4, 1.7 Hz, 1H), 8.39 (dt, *J* = 8.2, 1.5 Hz, 1H), 8.05 (d, *J* = 2.0 Hz, 1H), 8.04–8.00 (m, 1H), 7.90 (dd, *J* = 8.8, 1.9 Hz, 1H), 7.55 (dd, *J* = 8.3, 4.3 Hz, 1H), 5.72 (d, *J* = 0.8 Hz, 1H) ppm. HRMS (ESI$^+$) calc. for $C_{10}H_8NO_2$ $[MH]^+$ 174.0550, found 174.0.



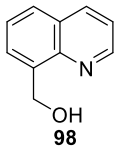
96

The title compound (**96**)[48] was obtained as a white solid (12.0 mg, 38% yield) using the described general method [from **72** (0.20 mmol) and the variant RT2/V78I/A184I/A330P (0.20 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (500 MHz, CD_3OD) δ 8.83 (dd, *J* = 4.3 Hz, 1.9 Hz, 1H), 8.66 (dd, *J* = 8.4 Hz, 1.8 Hz, 1H), 7.47 (dd, *J* = 8.4 Hz, 4.3 Hz, 1H), 7.41 (dd, *J* = 7.8 Hz, 1.1 Hz, 1H), 6.83 (d, *J* = 7.7 Hz, 1H), 2.65 (d, *J* = 1.0 Hz, 3H) ppm. ^{13}C NMR (125 MHz, CD_3OD) δ = 151.6, 148.8, 147.1, 131.8, 129.8, 125.9, 120.5, 119.2, 107.8, 16.4 ppm. HRMS (ESI$^+$) calc. for $C_{10}H_{10}NO$ $[MH]^+$ 160.0757, found 160.0757.



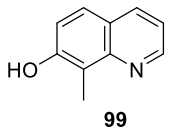
97

The title compound (**97**)[12] was obtained as a white solid (5.4 mg, 3% yield) using the described general method [from **72** (0.20 mmol) and the variant RP/H171L/I263G (0.10 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (500 MHz, CD_3OD) δ 8.48 (dd, *J* = 4.8 Hz, 1.7 Hz, 1H), 7.75 (dd, *J* = 7.7 Hz, 1.6 Hz, 1H), 7.41 (dd, *J* = 7.7 Hz, 4.9 Hz, 1H), 6.80 (dd, *J* = 9.6 Hz, 1.8 Hz, 1H), 6.57 (dd, *J* = 9.6 Hz, 3.9 Hz, 1H), 3.99 (dd, *J* = 3.9 Hz, 1.8 Hz, 1H), 1.89 (s, 3H) ppm. ^{13}C NMR (126 MHz, CD_3OD) δ = 153.8, 147.2, 136.0, 130.0, 127.6, 127.2, 123.5, 61.3, 60.8, 17.7 ppm. HRMS (ESI^+) calc. for $C_{10}H_{10}NO$ $[MH]^+$ 160.0757, found 160.0757.



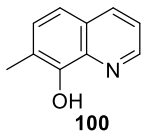
98

The title compound (**98**)[49] was obtained as a pale brown solid (8.7 mg, 27% yield) using the described general method [from **72** (0.20 mmol) and the variant R19/F87A/A328L (0.10 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (500 MHz, CD_3OD) δ 8.86 (dd, *J* = 4.3 Hz, 1.8 Hz, 1H), 8.33 (dd, *J* = 8.3 Hz, 1.8 Hz, 1H), 7.86 – 7.82 (m, 2H), 7.59 (t, *J* = 7.6 Hz, 1H), 7.52 (dd, *J* = 8.3 Hz, 4.2 Hz, 1H), 5.27 (s, 2H) ppm. ^{13}C NMR (125 MHz, CD_3OD) δ 150.5, 146.9, 140.0, 138.2, 129.7, 128.3, 128.1, 127.7, 122.4, 62.1 ppm. HRMS (ESI^+) calc. for $C_{10}H_{10}NO$ $[MH]^+$ 160.0757, found 160.0756.



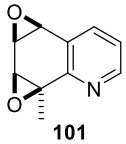
99

The title compound (**99**)[49] was obtained as a white solid (1.2 mg, 22% yield) using the described general method [from **97** (0.04 mmol) and the variant RT2/S72G/A330W (0.10 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (500 MHz, CD_3OD) δ 8.76 (dd, *J* = 4.4 Hz, 1.8 Hz, 1H), 8.19 (dd, *J* = 8.2 Hz, 1.8 Hz, 1H), 7.64 (d, *J* = 8.8 Hz, 1H), 7.31 (dd, *J* = 8.1 Hz, 4.4 Hz, 1H), 7.23 (d, *J* = 8.8 Hz, 1H), 2.59 (s, 3H) ppm. ^{13}C NMR (125 MHz, CD_3OD) δ 155.9, 148.9, 148.1, 136.8, 126.0, 123.3, 118.4, 117.6, 117.2, 8.5 ppm. HRMS (ESI^+) calc. for $C_{10}H_{10}NO$ $[MH]^+$ 160.0757, found 160.0757.



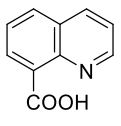
100

The title compound (**100**)[50] was obtained as a white solid (1.0 mg, 19% yield) using the described general method [from **97** (0.04 mmol) and the variant RT2/S72G/A330W (0.10 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (400 MHz, CD_3OD) δ 8.76 (dd, *J* = 4.3 Hz, 1.6 Hz, 1H), 8.20 (dd, *J* = 8.4 Hz, 1.5 Hz, 1H), 7.42 (dd, *J* = 8.3 Hz, 4.2 Hz, 1H), 7.36 (d, *J* = 8.5 Hz, 1H), 7.29 (d, *J* = 8.4 Hz, 1H), 2.43 (s, 3H) ppm. HRMS (ESI^+) calc. for $C_{10}H_{10}NO$ $[MH]^+$ 160.0757, found 160.0758.



101

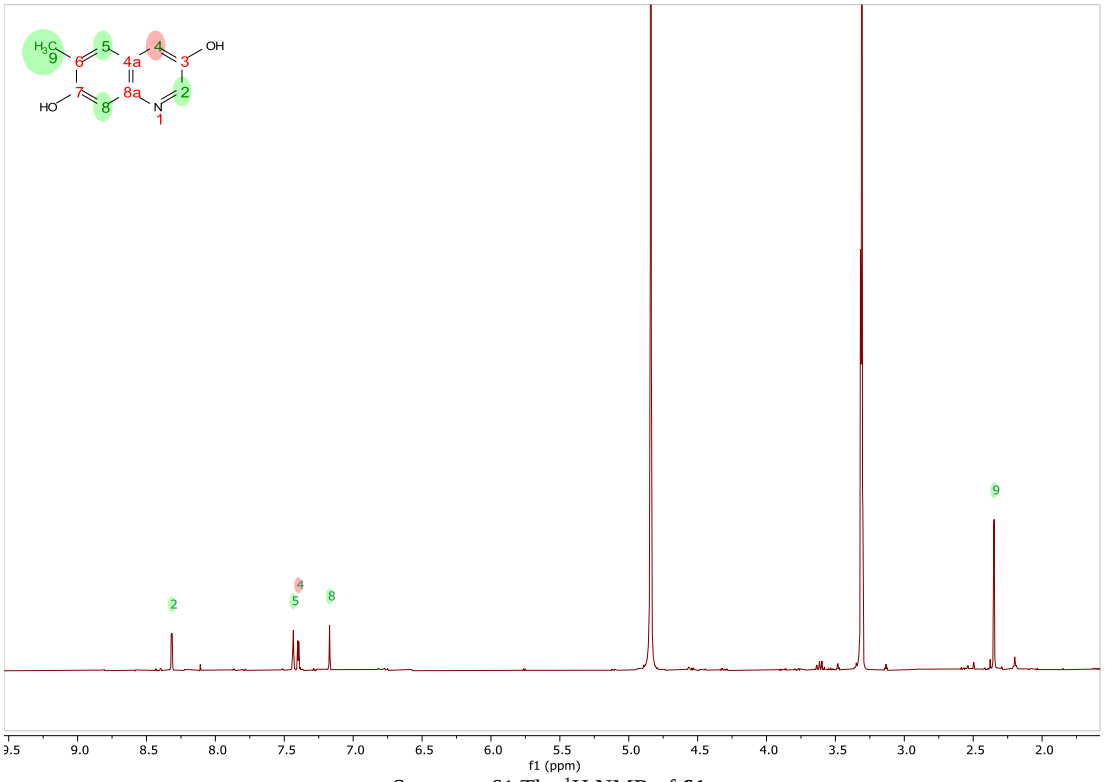
The title compound (**101**) was obtained as a white solid (3.2 mg, 11% yield) using the described general method [from **72** (0.20 mmol) and the variant RP/H171L/I263G (0.10 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography^{1}H NMR (400 MHz, CD_3OD) δ 8.60 (dd, *J* = 4.9, 1.7 Hz, 1H), 8.09 (dd, *J* = 7.7, 1.8 Hz, 1H), 7.45 (dd, *J* = 7.7, 4.9 Hz, 1H), 4.11 (d, *J* = 3.7 Hz, 1H), 3.99 (t, *J* = 3.4 Hz, 1H), 3.83 (d, *J* = 3.1 Hz, 1H), 1.79 (s, 3H) ppm. HRMS (ESI^+) calc. for $C_{10}H_{10}NO_2$ $[MH]^+$ 176.0707, found 176.0706.



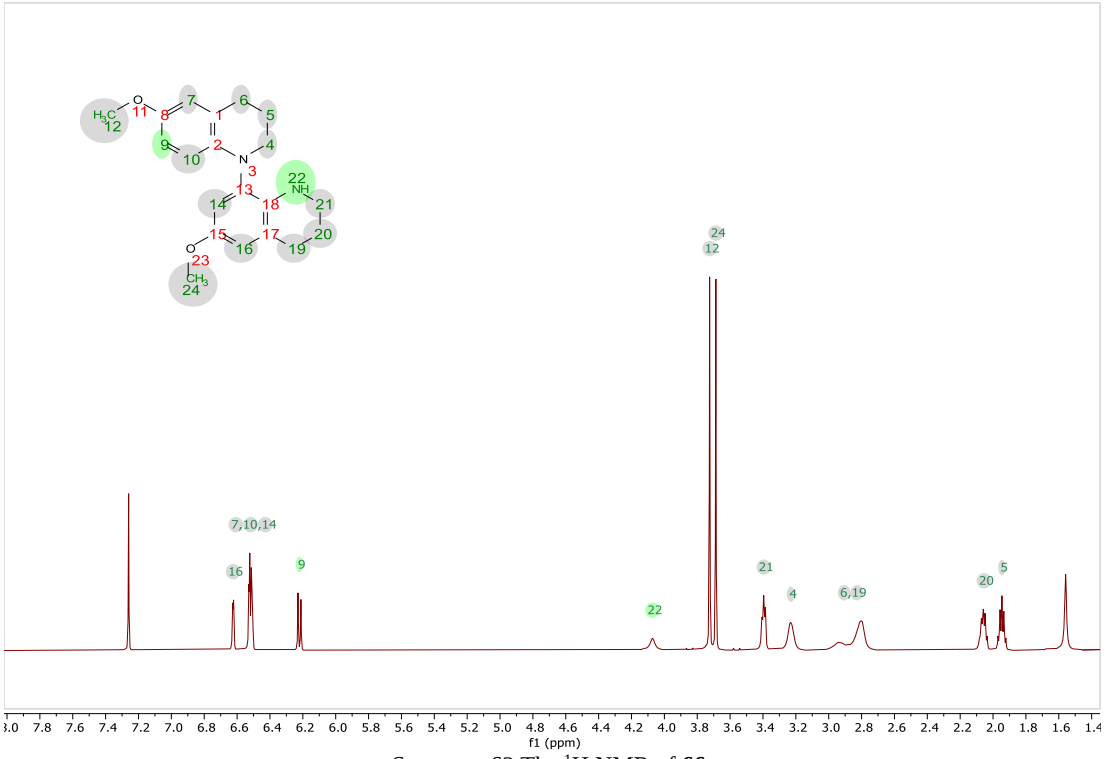
102

The title compound (**102**)[51] was obtained as a pale brown solid (4.5 mg, 15% yield) using the described general method [from **72** (0.20 mmol) and the variant RP (0.10 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.88 (d, *J* = 4.3 Hz, 1H), 8.76 (d, *J* = 7.4 Hz, 1H), 8.36 (d, *J* = 8.4 Hz, 1H), 8.05 (d, *J* = 8.2 Hz, 1H), 7.71 (t, *J* = 7.8 Hz,

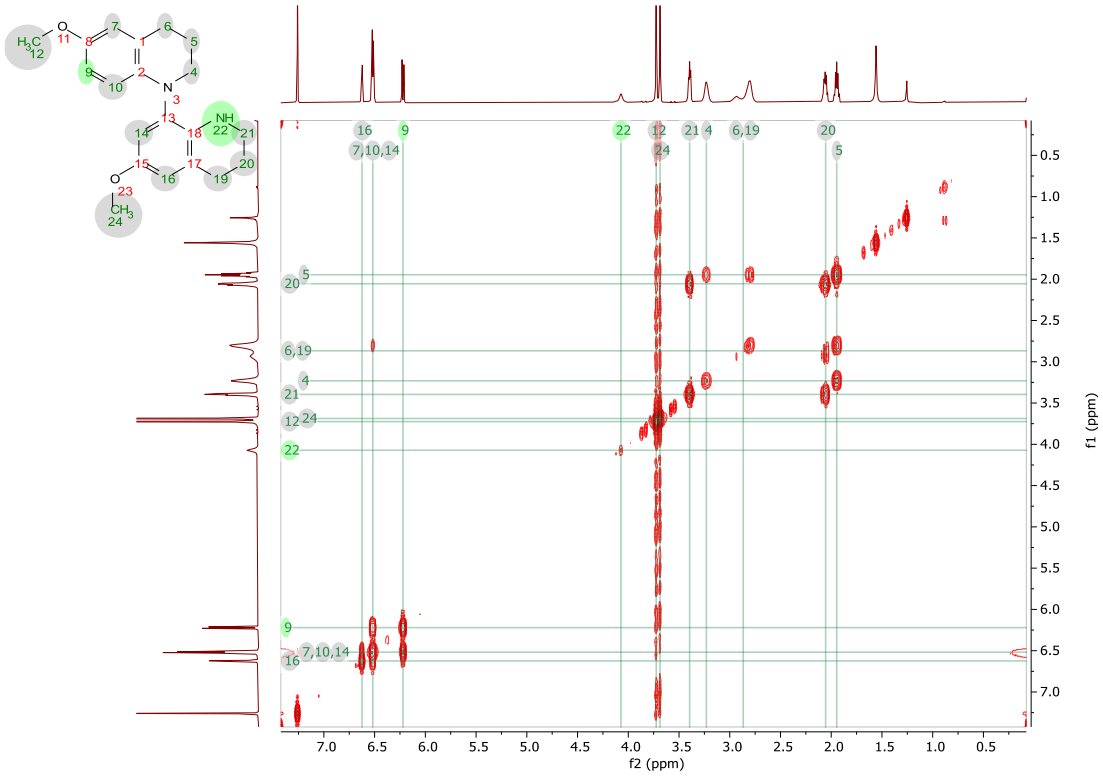
1H), 7.57 (dd, J = 8.4, 4.3 Hz, 1H) ppm. HRMS (ESI$^+$) calc. for $C_{10}H_8NO_2$ $[MH]^+$ 174.0550, found 175.0551.



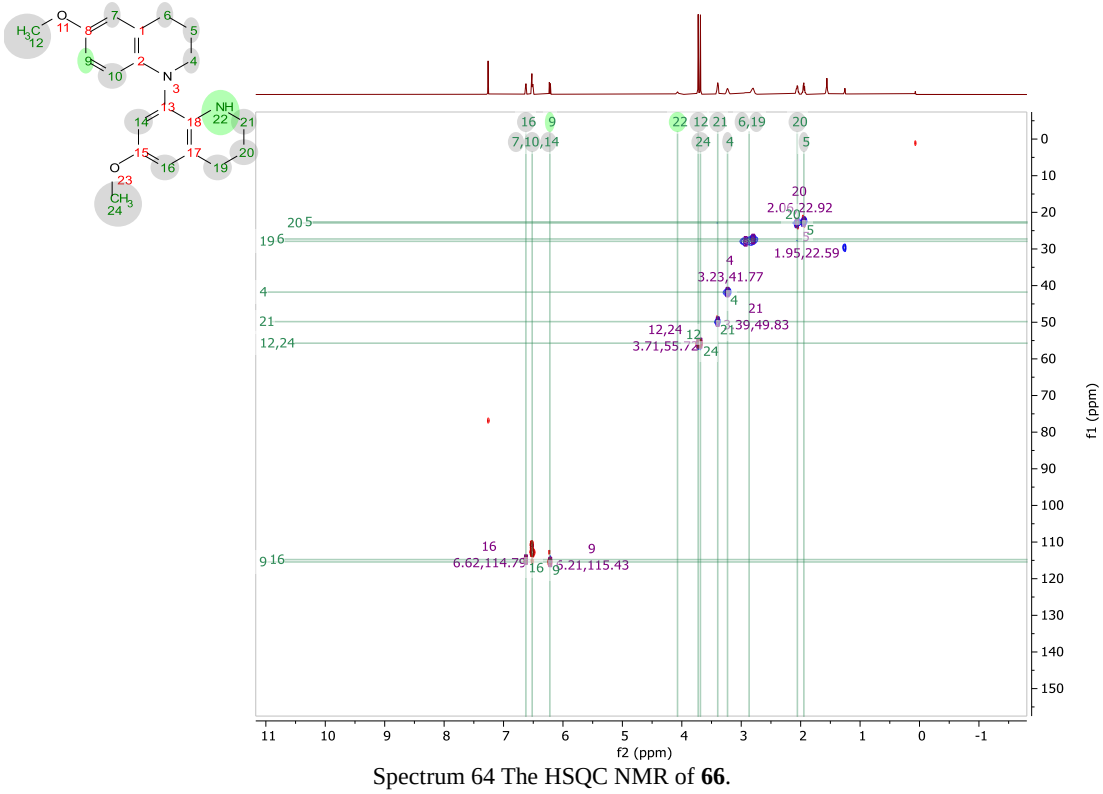
Spectrum 61 The ^{1}H NMR of **61**.



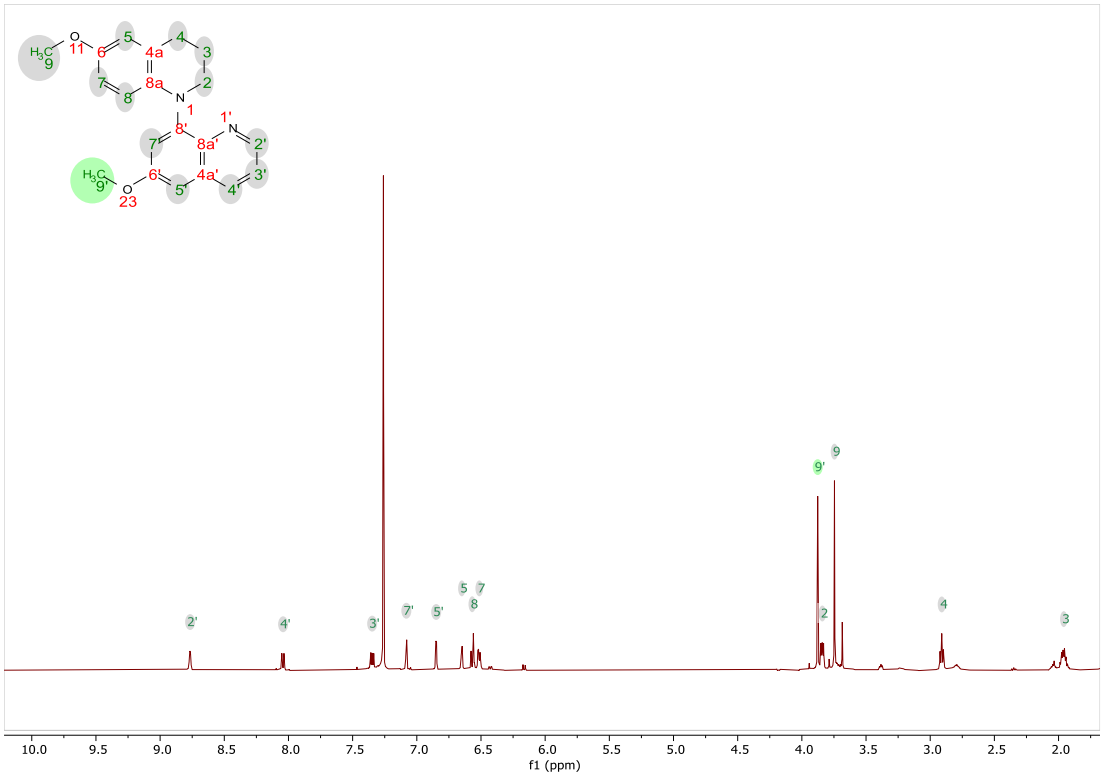
Spectrum 62 The ^{1}H NMR of **66**.



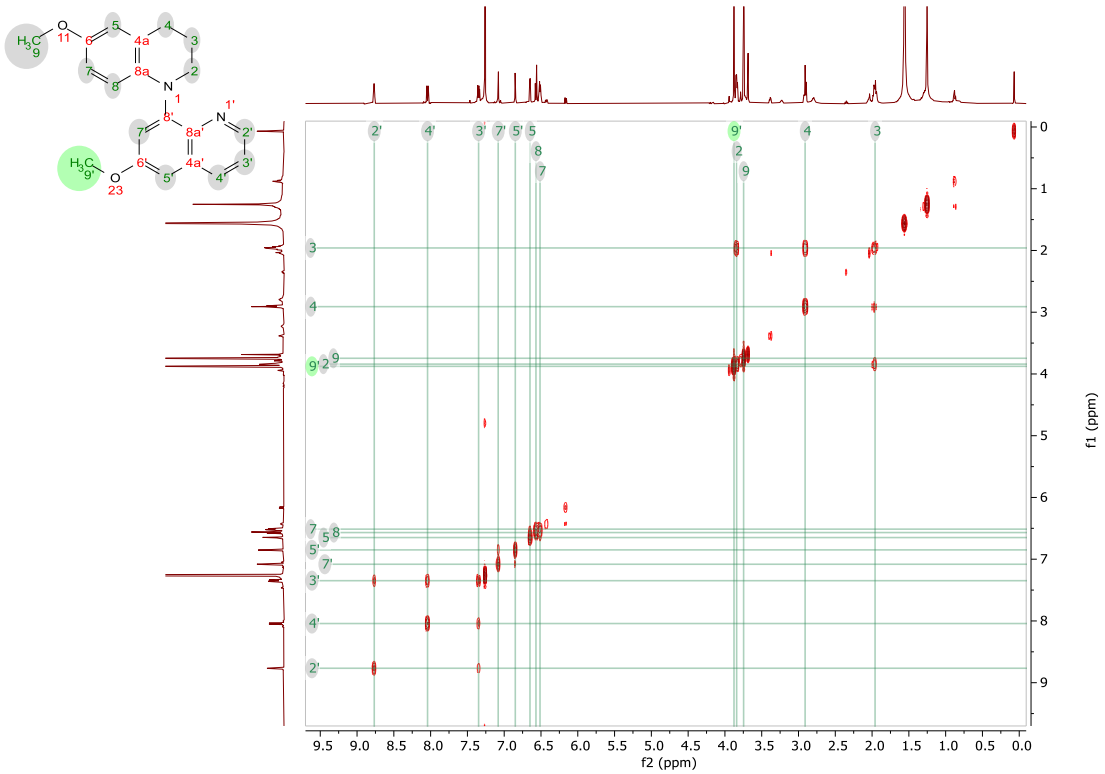
Spectrum 63 The COSY NMR of **66**.



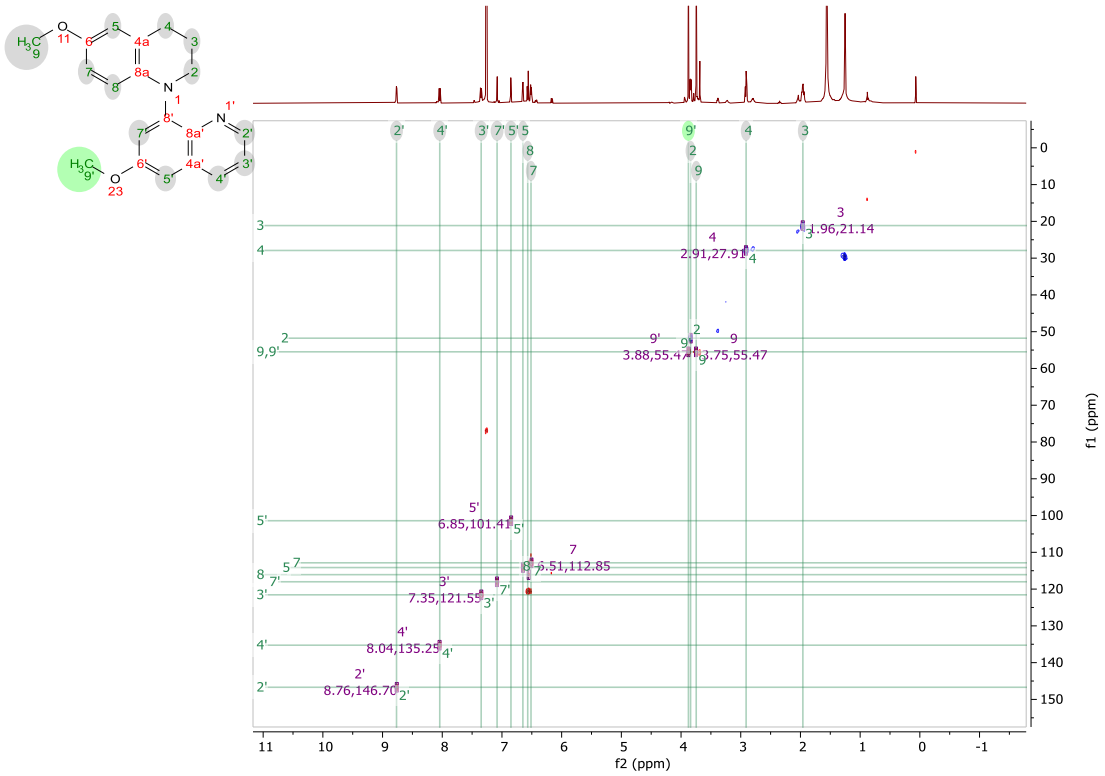
Spectrum 64 The HSQC NMR of **66**.



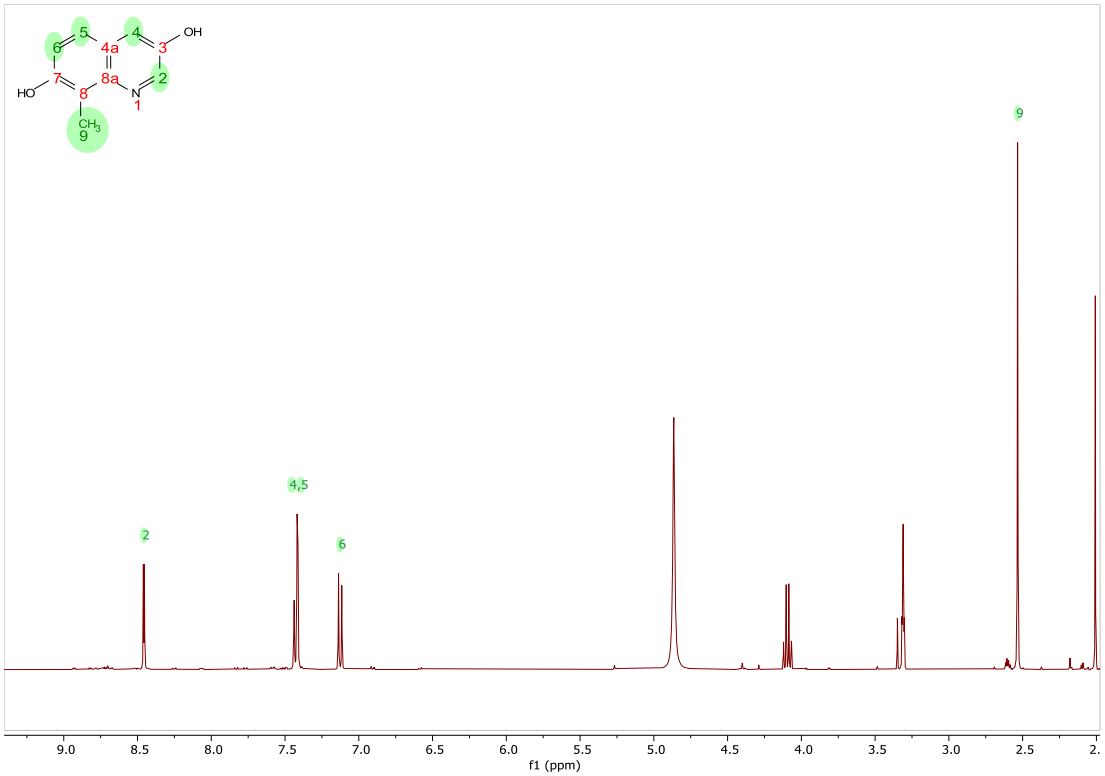
Spectrum 65 The ^{1}H NMR of **67**.



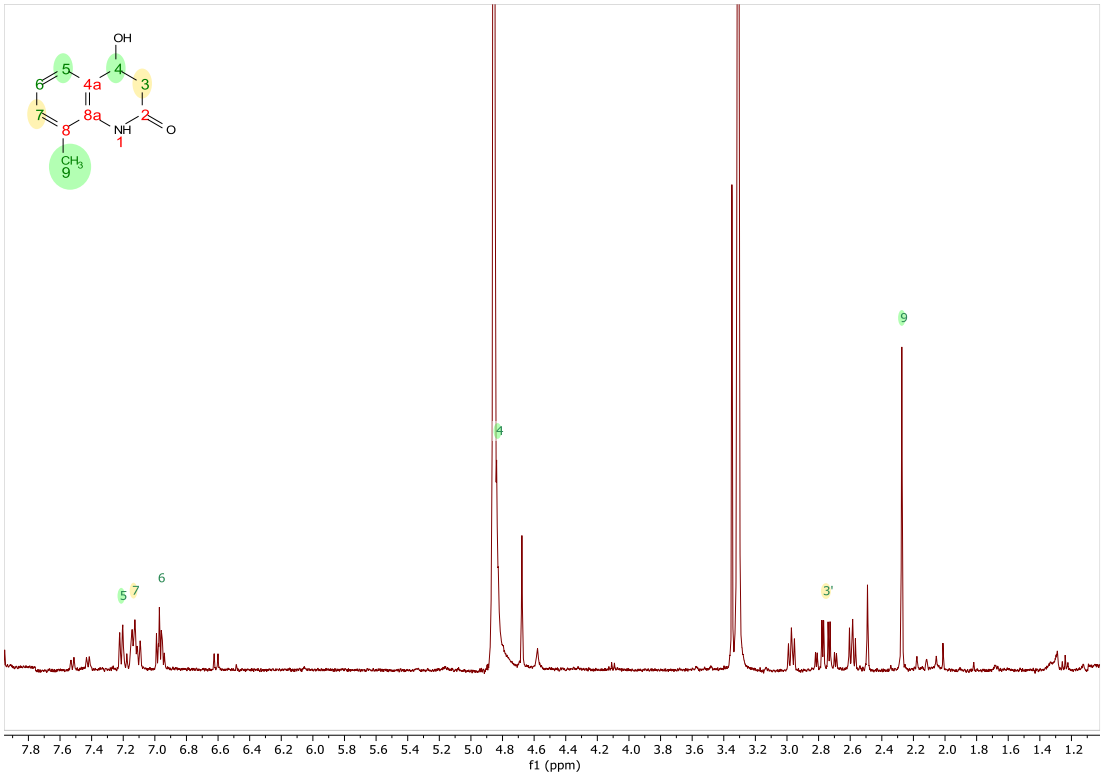
Spectrum 66 The COSY NMR of **67**.



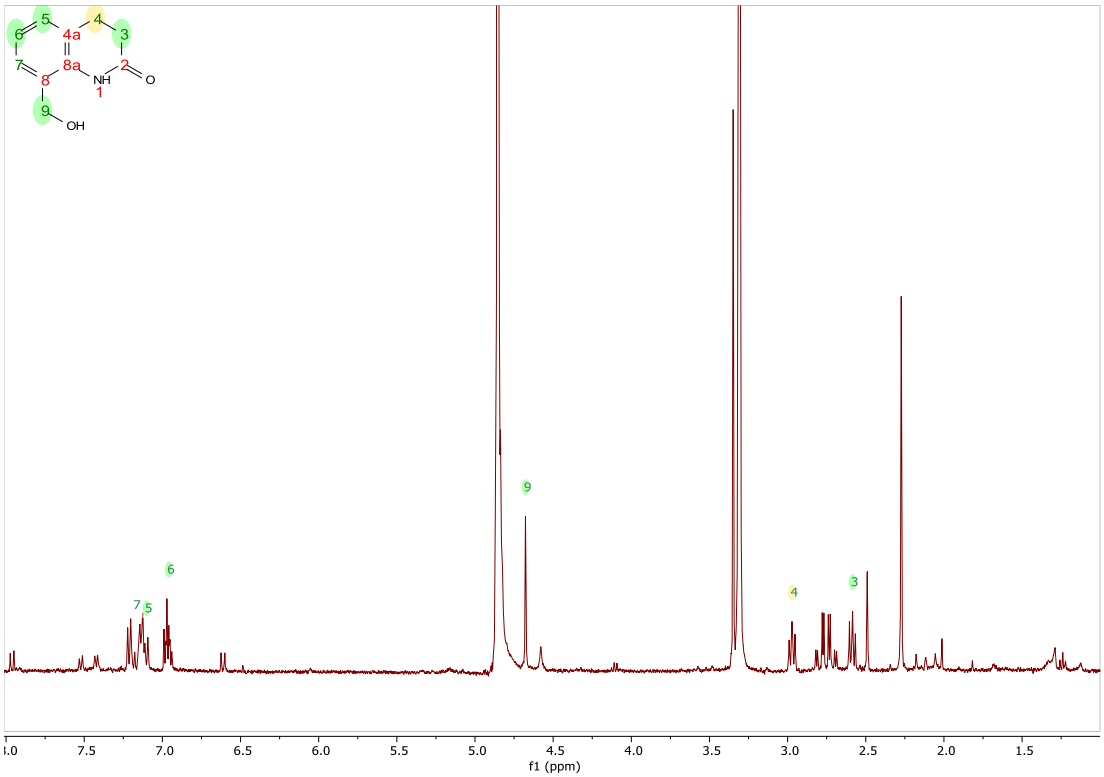
Spectrum 67 The HSQC NMR of **67**.



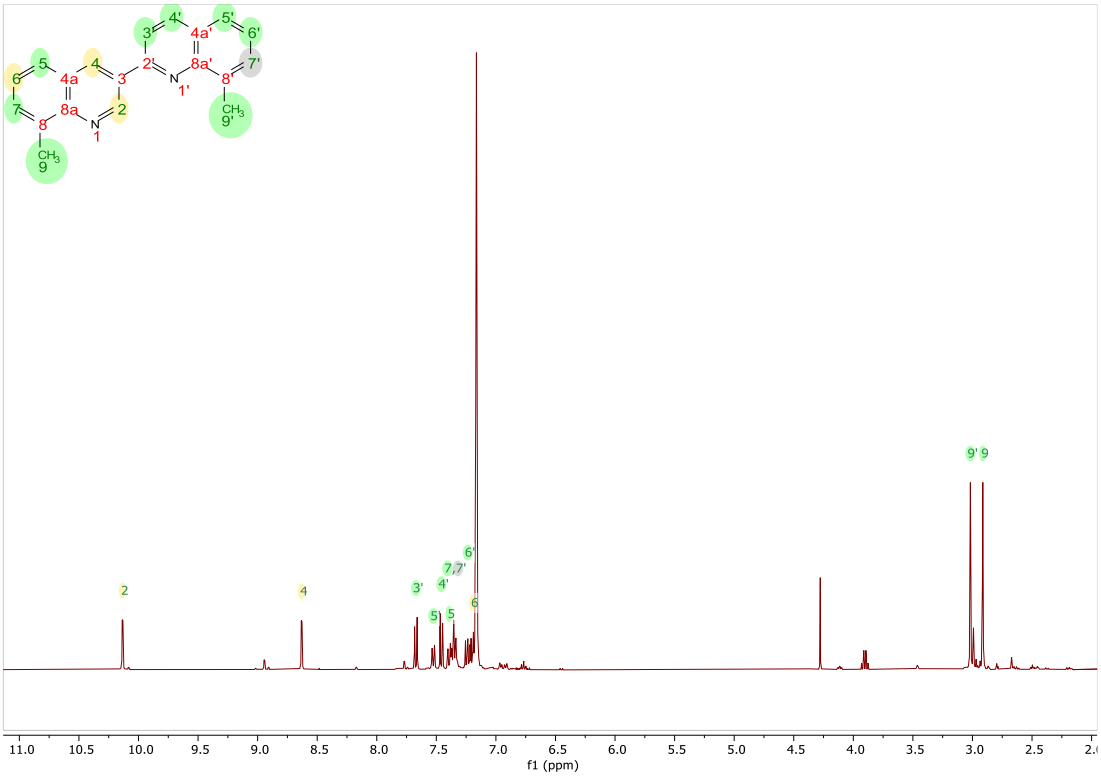
Spectrum 68 The ^{1}H NMR of **77**.



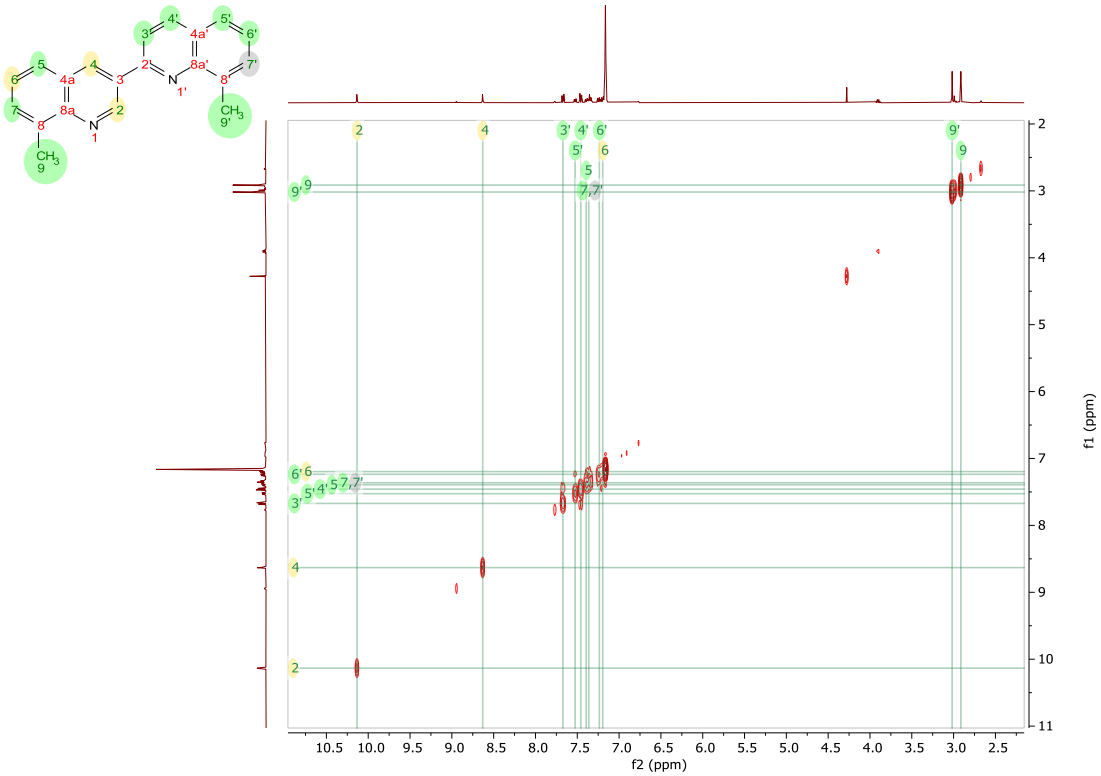
Spectrum 69 The ^{1}H NMR of **78**.



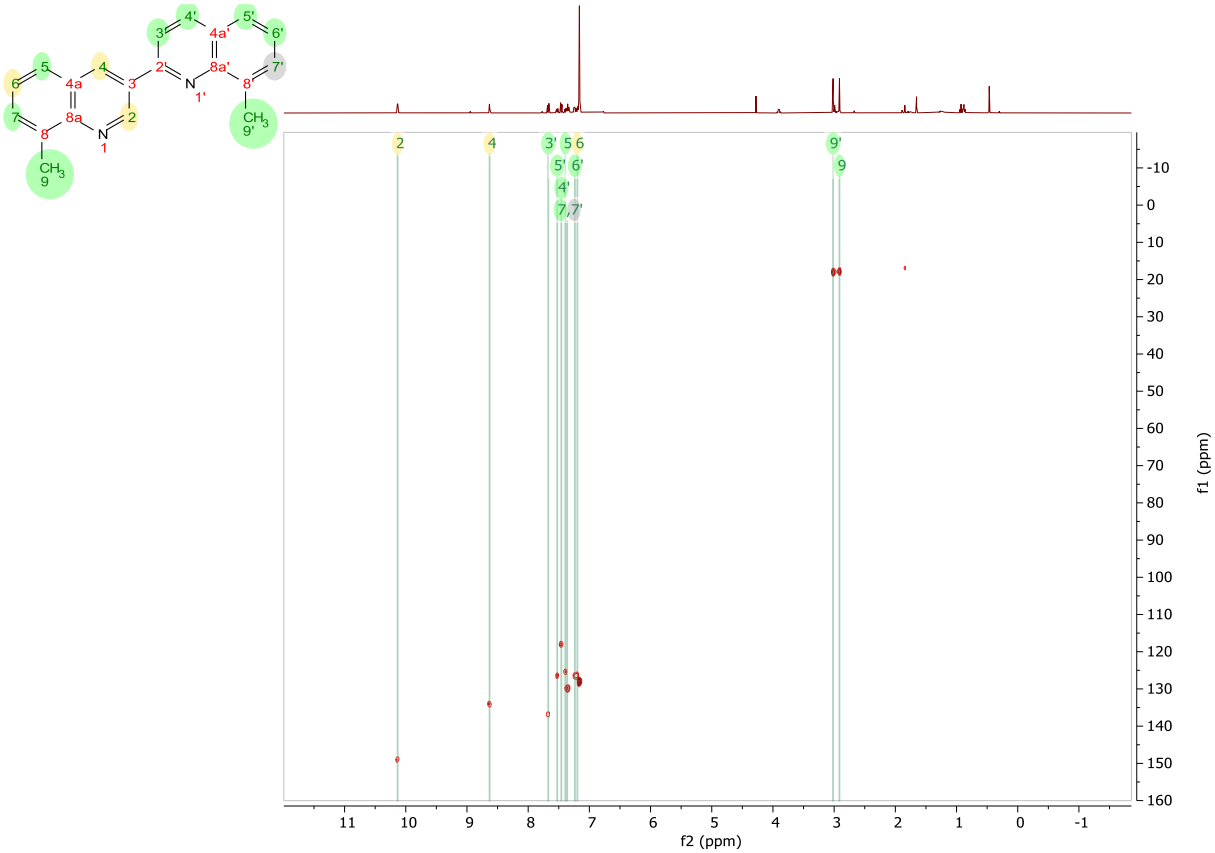
Spectrum 70 The ^{1}H NMR of **79**.



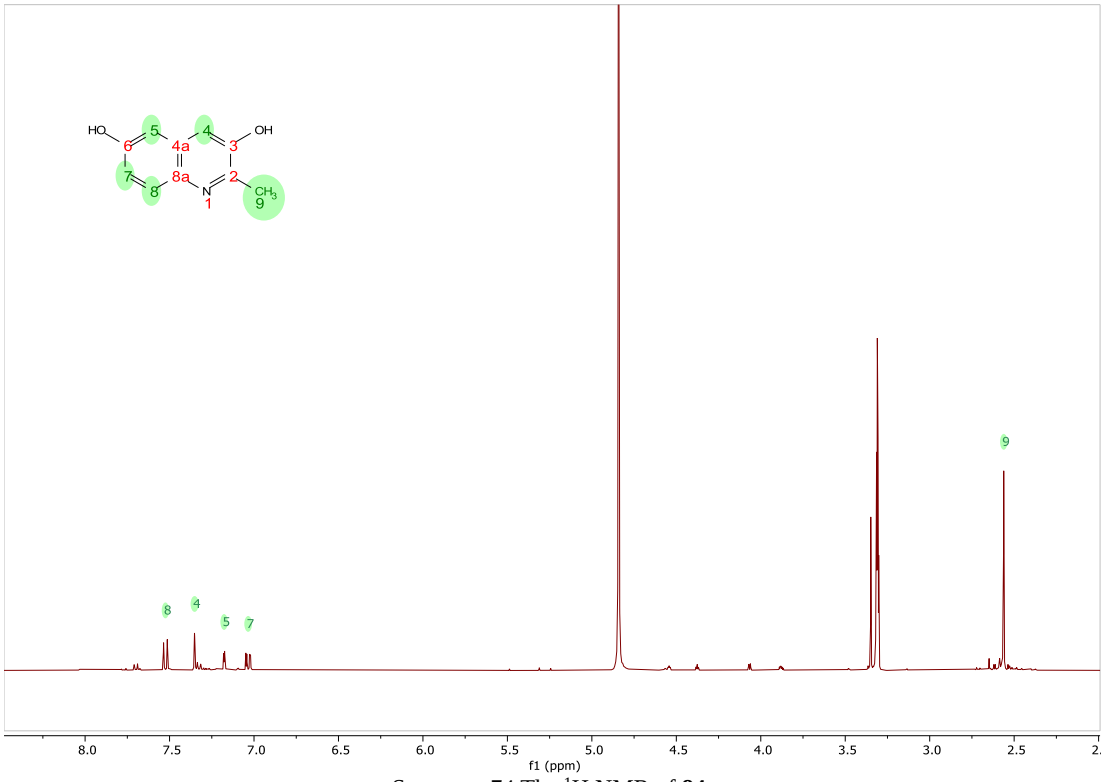
Spectrum 71 The ^{1}H NMR of **80**.



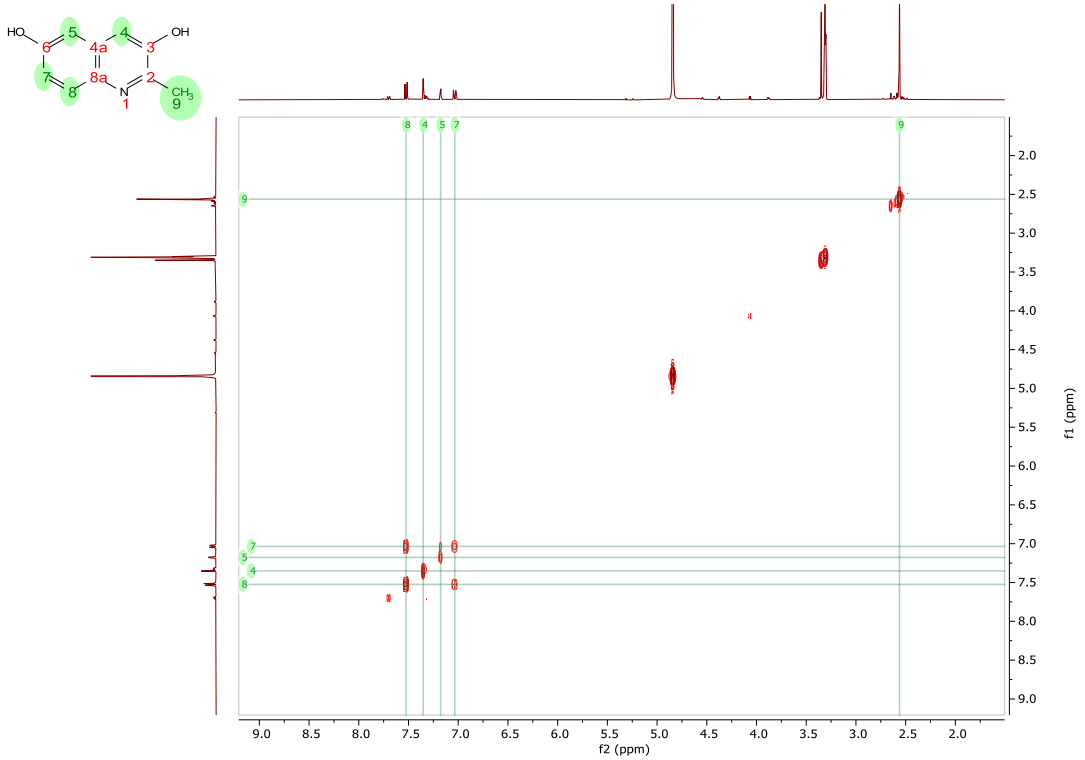
Spectrum 72 The COSY NMR of **80**.



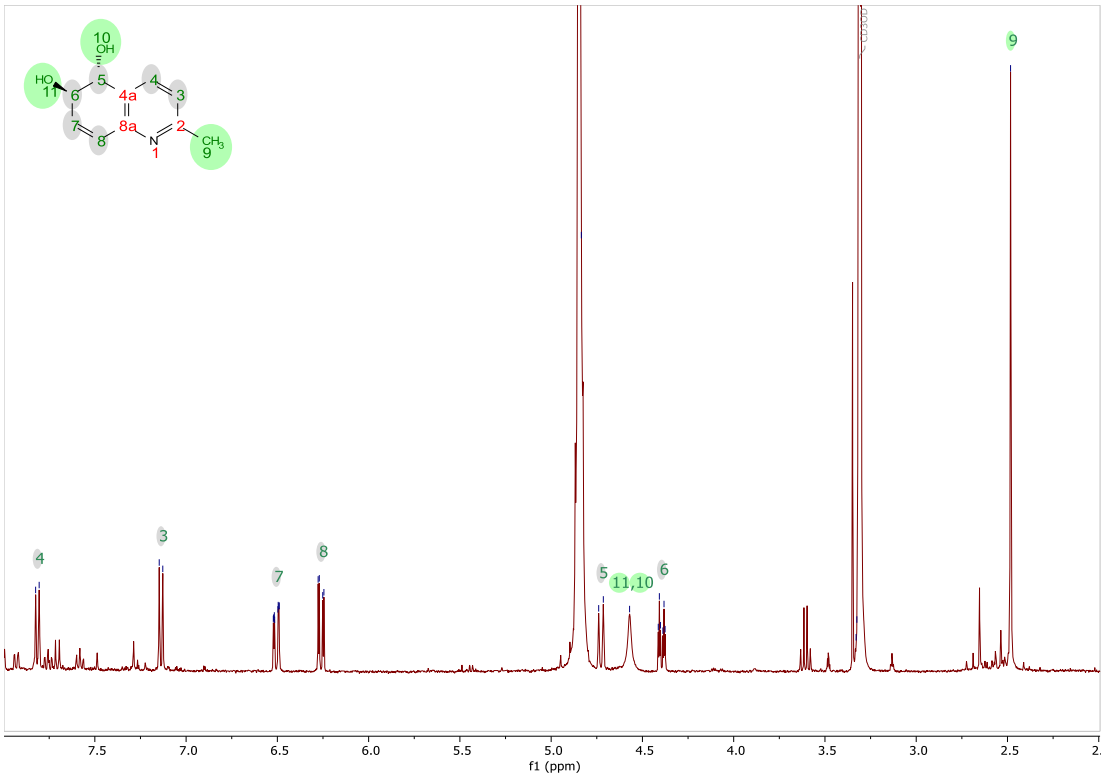
Spectrum 73 The HSQC NMR of **80**.



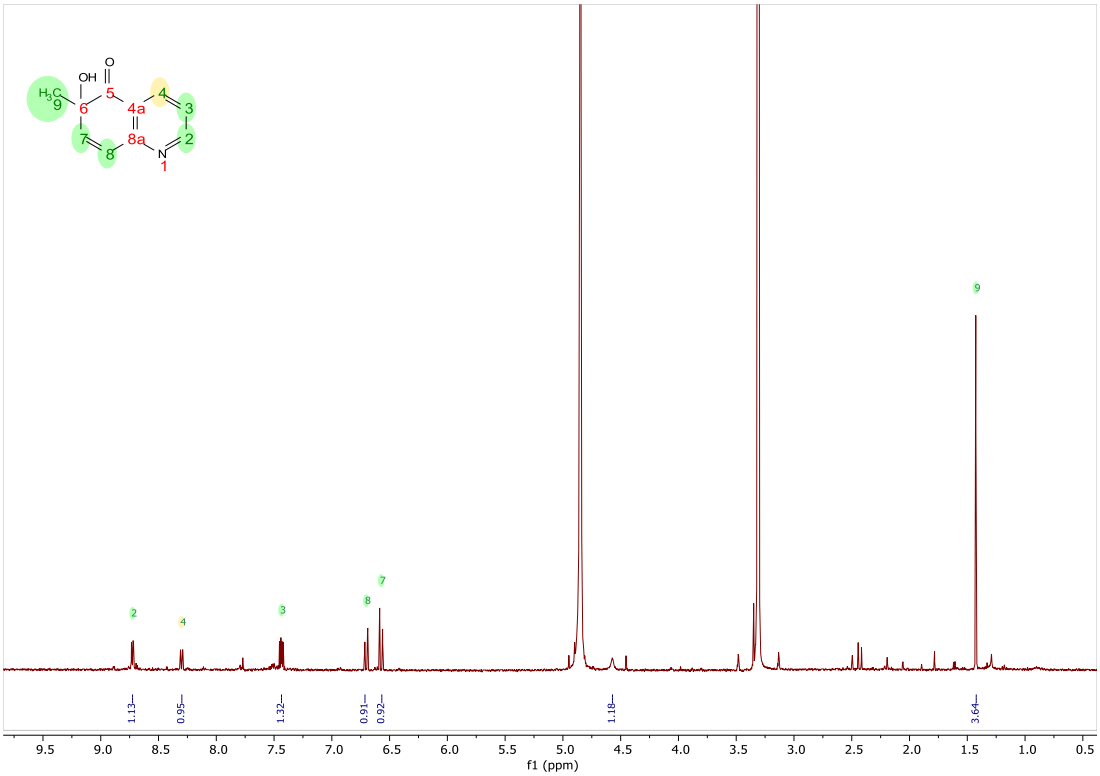
Spectrum 74 The ^{1}H NMR of **84**.



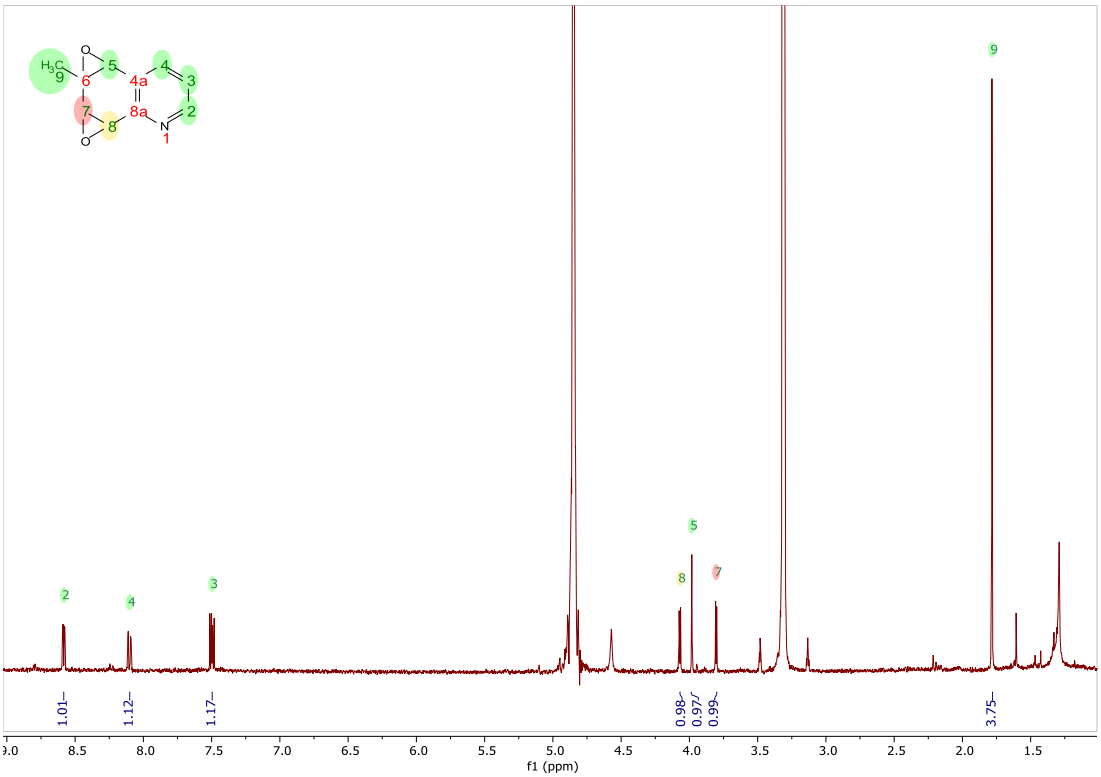
Spectrum 75 The COSY NMR of **84**.



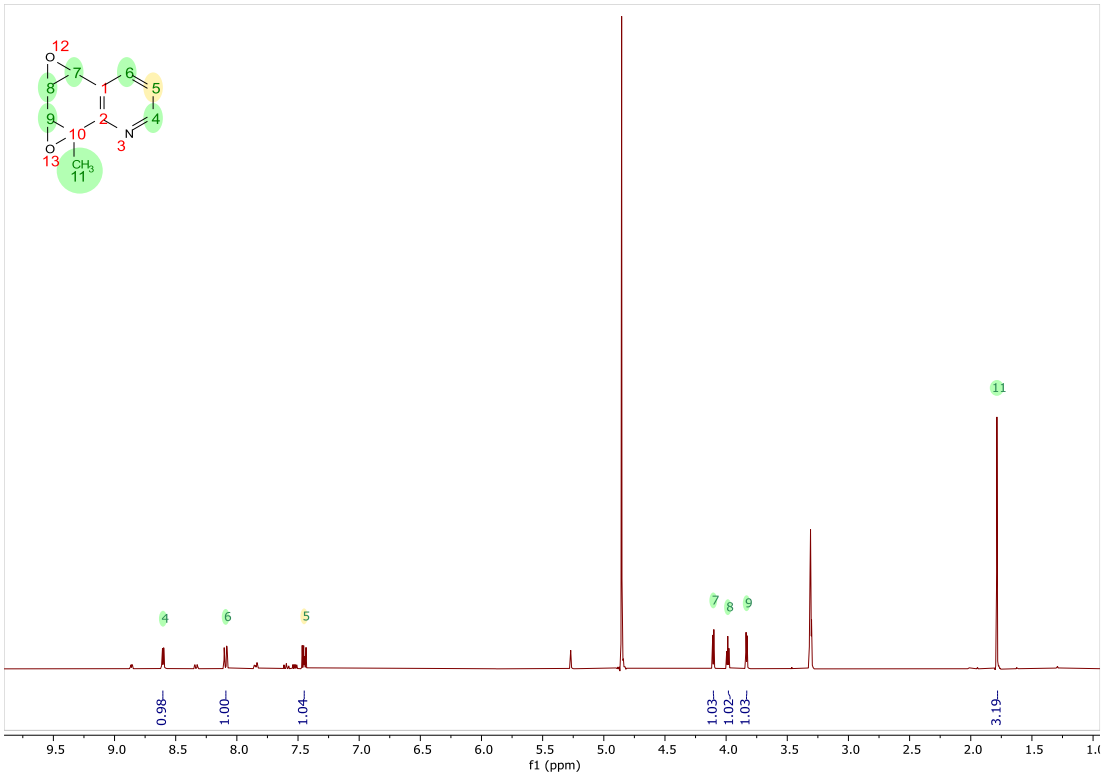
Spectrum 76 The ^{1}H NMR of **86**.



Spectrum 77 The ^{1}H NMR of **92**.

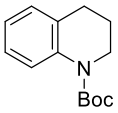


Spectrum 78 The ^{1}H NMR of **93**.



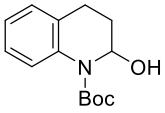
Spectrum 79 The ^{1}H NMR of **101**.

Appendix 4.4 The NMR and MS data of the products in Chapter 6.



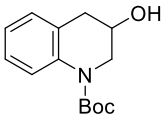
103

To a solution of **13** (931.0 mg, 7.000 mmol) in 65.0 mL anhydrous tetrahydrofuran was added triethylamine (1.100 mL, 7.892 mmol). Di-tert-butyl-dicarbonate (1.987 g, 9.100 mmol) dissolved in 5.00 mL anhydrous tetrahydrofuran was added slowly so that the temperature was maintained below 32 ºC and the mixture was stirred at ambient temperature for 4 hours. Tetrahydrofuran was removed *in vacuo*, and the crude was extracted by ethyl acetate (3 × 100 mL) and dried by anhydrous Na_2SO_4. The combined organic layers were purified by silica gel chromatography (petrol/EtOAc, 6:1) to afford a yellow oil **103**[52] (234.5 mg, 14%). R_f = 0.58 (petrol/EtOAc, 6:1). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.68–7.61 (m, 1H), 7.13 (dddt, *J* = 7.9 Hz, 7.2 Hz, 1.6 Hz, 0.7 Hz, 1H), 7.07 (ddq, *J* = 7.5 Hz, 1.5 Hz, 0.7 Hz, 1H), 6.98 (td, *J* = 7.4 Hz, 1.2 Hz, 1H), 3.75–3.68 (m, 2H), 2.77 (t, *J* = 6.6 , 2H), 1.53 (s, 9H) ppm. ^{13}C NMR (101 MHz, $CDCl_3$) δ 154.1, 138.8, 130.0, 128.6, 125.8, 124.3, 123.4, 80.8, 44.8, 28.5, 27.6, 23.7 ppm. HRMS (ESI^+) calc. for $C_{14}H_{20}NO_2$ $[MH]^+$ 234.1489, found 234.1489.



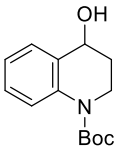
104

The title compound (**104**)[53] was obtained as a yellow oil (1.2 mg, 3% yield) using the described general method [from **103** (0.20 mmol) and the variant K19/A82M/F87A (0.10 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.51 (d, *J* = 8.2 Hz, 1H), 7.16 (dt, *J* = 7.5, 0.9 Hz, 1H), 7.10 (d, *J* = 7.4 Hz, 1H), 6.99 (td, *J* = 7.4, 1.2 Hz, 1H), 5.83–5.75 (m, 1H), 3.91 (s, 1H), 2.67 (ddd, *J* = 14.8, 6.5, 3.9 Hz, 1H), 2.54 (ddd, *J* = 14.7, 10.9, 3.6 Hz, 1H), 2.24 (dtd, *J* = 12.9, 6.3, 3.9 Hz, 1H), 1.79 (tdd, *J* = 13.4, 9.2, 3.9 Hz, 1H), 1.55 (s, 9H) ppm. ^{13}C NMR (126 MHz, $CDCl_3$) δ 154.79, 136.48, 132.13, 127.34, 126.37, 123.94, 123.65, 82.21, 79.15, 31.16, 28.53 (3C), 24.75 ppm. HRMS (ESI^+) calc. for $C_{14}H_{19}NO_3Na$ $[MNa]^+$ 272.1257, found 272.1257.



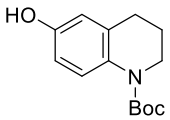
105

The title compound (**105**)[54] was obtained as a white solid (0.6 mg, 1% yield) using the described general method [from **103** (0.20 mmol) and the variant R19/F87A/A328G/P329G/A330G (0.10 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.65 (d, *J* = 8.5 Hz, 1H), 7.17–7.13 (m, 1H), 7.05–7.01 (m, 2H), 4.29 (q, *J* = 5.2 Hz, 1H), 3.77 (d, *J* = 4.6 Hz, 2H), 3.09 (dd, *J* = 16.5, 5.3 Hz, 1H), 2.81 (dd, *J* = 16.5, 5.5 Hz, 1H), 1.52 (s, 6H) ppm. HRMS (ESI^+) calc. for $C_{14}H_{18}NO_3$ $[MH]^+$ 250.1438, found 250.1437.



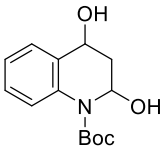
106

The title compound (**106**)[55] was obtained as a white solid (22.0 mg, 47% yield) using the described general method [from **103** (0.20 mmol) and the variant R19/F87I (0.10 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (400 MHz, CD_3OD) δ 7.66 (dd, *J* = 8.4, 1.2 Hz, 1H), 7.43–7.36 (m, 1H), 7.20 (ddd, *J* = 8.5, 7.2, 1.7 Hz, 1H), 7.07 (td, *J* = 7.5, 1.2 Hz, 1H), 4.69 (t, *J* = 5.0 Hz, 1H), 3.94 (ddd, *J* = 12.9, 6.5, 4.6 Hz, 1H), 3.61 (ddd, *J* = 13.1, 9.2, 4.1 Hz, 1H), 2.12–1.99 (m, 1H), 1.93 (dddd, *J* = 13.6, 6.5, 5.5, 4.1 Hz, 1H), 1.52 (s, 11H) ppm. ^{13}C NMR (101 MHz, CD_3OD) δ 155.34, 138.73, 132.88, 129.31, 128.36, 124.73, 124.56, 82.30, 66.36, 42.05, 33.43, 28.60 ppm. HRMS (ESI^+) calc. for $C_{14}H_{19}NO_3Na$ $[MNa]^+$ 272.1257, found 272.1258.



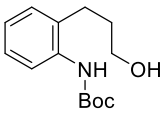
107

The title compound (**107**)[56] was obtained as a white solid (0.8 mg, 2% yield) using the described general method [from **103** (0.20 mmol) and the variant GVQ/A82M/I263G (0.10 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.54–7.44 (m, 1H), 6.62 (dd, *J* = 9.0, 3.0 Hz, 1H), 6.55 (d, *J* = 2.9 Hz, 1H), 3.70 – 3.64 (m, 2H), 2.71 (t, *J* = 6.7 Hz, 2H), 1.90 (p, *J* = 6.4 Hz, 2H), 1.51 (s, 9H) ppm. HRMS (ESI$^+$) calc. for $C_{14}H_{18}NO_3$ $[MH]^+$ 250.1438, found 250.1437.



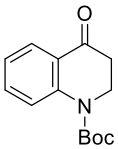
108
syn & *anti*

The title compound (**108**) was obtained as a white solid (8.6 mg, 18% yield, *syn* : *anti* = 0.75 : 1) using the described general method [from **103** (0.20 mmol) and the variant R19/F87A/A328G/P329G/A330G (0.10 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR of *anti*-**108** (400 MHz, $CDCl_3$) δ 7.74 (dd, *J* = 8.4, 1.2 Hz, 1H), 7.41 (dd, *J* = 7.6, 1.7 Hz, 1H), 7.29–7.24 (m, 1H), 7.11 (td, *J* = 7.4, 1.2 Hz, 1H), 6.04 (q, *J* = 4.6 Hz, 1H), 4.73 (dt, *J* = 7.7, 4.9 Hz, 1H), 3.88 (d, *J* = 4.4 Hz, 1H), 2.82 (d, *J* = 7.9 Hz, 1H), 2.29 (t, *J* = 4.8 Hz, 2H), 1.56 (s, 9H) ppm. ^{1}H NMR of *syn*-**108** (400 MHz, $CDCl_3$) δ 7.63 (dd, *J* = 8.2, 1.1 Hz, 1H), 7.33 (dd, *J* = 7.5, 1.7 Hz, 1H), 7.29–7.24 (m, 1H), 7.07 (td, *J* = 7.5, 1.1 Hz, 1H), 5.88 (td, *J* = 6.0, 3.2 Hz, 1H), 4.85 (dt, *J* = 7.4, 3.8 Hz, 1H), 3.98 (d, *J* = 3.3 Hz, 1H), 2.35 (ddd, *J* = 13.7, 6.6, 0.6 Hz, 1H), 2.09 (ddd, *J* = 13.5, 6.4, 3.2 Hz, 1H), 1.78 (d, *J* = 4.6 Hz, 1H), 1.57 (s, 9H) ppm. HRMS (ESI$^+$) calc. for $C_{14}H_{20}NO_4$ $[MH]^+$ 266.1387, found 266.1384.



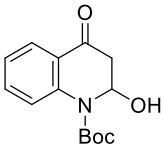
109

The title compound (**109**)[57] was obtained as a colourless solid (1.2 mg, 3% yield) using the described general method [from **103** (0.20 mmol) and the variant R19/F87A/A328G/P329G/A330G (0.10 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.71 (d, *J* = 6.7 Hz, 1H), 7.26 (br s, 1H), 7.01–7.21 (m, 3H), 3.59 (m, 2H), 2.71 (t, *J* = 7.2 Hz, 2H), 2.10 (br s, 1H), 1.81–1.88 (m, 2H), 1.51 (s, 9H) ppm. ^{13}C NMR (400 MHz, $CDCl_3$) δ 153.8, 136.3, 131.8, 129.5, 126.7, 124.1, 122.5, 80.1, 60.7, 32.3, 29.3, 26.5 ppm. HRMS (ESI$^+$) calc. for $C_{14}H_{22}NO_3$ $[MH]^+$ 252.1595, found 252.1591.



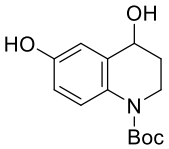
110

The title compound (**110**)[55] was obtained as a white solid (24.0 mg, 48% yield) using the described general method [from **106** (0.20 mmol) and the variant RP/I263A/E267V (0.01 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (400 MHz, CD_3OD) δ 7.92 (ddd, *J* = 7.9 Hz, 1.7 Hz, 0.5 Hz, 1H), 7.76 (ddd, *J* = 8.4 Hz, 1.1 Hz, 0.5 Hz, 1H), 7.54 (ddd, *J* = 8.5 Hz, 7.2 Hz, 1.7 Hz, 1H), 7.18 (ddd, *J* = 7.9 Hz, 7.3 Hz, 1.1 Hz, 1H), 4.19–4.11 (m, 2H), 2.78–2.70 (m, 2H), 1.55 (s, 9H) ppm. ^{13}C NMR (101 MHz, CD_3OD) δ 196.1, 154.3, 145.6, 135.1, 128.0, 126.2, 125.2, 125.1, 83.3, 45.5, 39.8, 28.5 ppm. HRMS (ESI$^+$) calc. for $C_{14}H_{18}NO_3$ $[MH]^+$ 248.1281, found 248.1283.

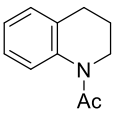


111

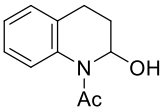
The title compound (**111**) was obtained as a white solid (0.6 mg, 1% yield) using the described general method [from **103** (0.20 mmol) and the variant R19/F87A/I263G/A264G (0.01 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (500 MHz, $CDCl_3$) δ 8.20–8.15 (m, 1H), 7.52 (td, *J* = 7.5, 1.4 Hz, 1H), 7.38 (t, *J* = 7.7 Hz, 1H), 7.30–7.27 (m, 1H), 5.92 (td, *J* = 3.9, 2.1 Hz, 1H), 3.40–3.33 (m, 2H), 3.19–3.12 (m, 1H), 1.62 (s, 9H) ppm. HRMS (ESI$^+$) calc. for $C_{14}H_{18}NO_4$ $[MH]^+$ 264.1231, found 264.1233.


112

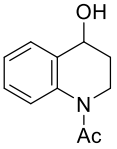
The title compound (**112**) was obtained as a white solid (5.2 mg, 11% yield) using the described general method [from **103** (0.20 mmol) and the variant GVQ/V78L/I263G (0.01 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.59 (d, *J* = 8.9 Hz, 1H), 6.84 (dd, *J* = 2.9, 0.8 Hz, 1H), 6.72 (ddd, *J* = 8.9, 3.0, 1.5 Hz, 1H), 5.06 (s, 1H), 4.69 (q, *J* = 10.2, 4.8, 4.7 Hz, 1H), 3.97 (ddd, *J* = 13.0, 6.4, 4.4 Hz, 1H), 3.58 (ddd, *J* = 13.2, 9.4, 3.9 Hz, 1H), 2.10 (ddd, *J* = 13.8, 9.3, 4.6 Hz, 1H), 1.95 (dddd, *J* = 13.7, 6.4, 5.3, 3.9 Hz, 2H), 1.52 (s, 9H) ppm. HRMS (ESI$^+$) calc. for $C_{14}H_{20}NO_4$ $[MH]^+$ 266.1387, found 264.1384.


113

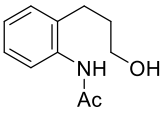
To a solution of **13** (1.000g, 7.519 mmol) and pyridine (730.0 μL, 9.023 mmol) in 45.0 mL DCM at 0 ºC, acetyl chloride (644.0 μL, 9.023 mmol) in 5.00 mL DCM was added dropwise. The mixture was stirred at ambient temperature for 2 hours and then washed with 100 mL saturated $NaHCO_3$, 100 mL 2 M HCl and 100 mL brine, then dried over anhydrous Na_2SO_4. The organic layer was then concentrated *in vacuo* and purified by silica gel chromatography (petrol/EtOAc, 6:1) to give **113**[58] (895.6 mg, 68% yield). R_f = 0.40 (petrol/EtOAc, 6:1). ^{1}H NMR (400 MHz, CD_3OD) δ 7.46–7.03 (m, 3H), 3.75 (t, *J* = 6.6 Hz, 2H), 2.73 (t, *J* = 6.7 Hz, 2H), 2.20 (s, 3H), 1.94 (p, *J* = 6.6 Hz, 2H) ppm. ^{13}C NMR (101 MHz, CD_3OD) δ 172.6, 129.5, 126.9 (d, *J* = 43.4 Hz), 125.9, 44.0, 27.6, 25.1, 23.1 ppm. HRMS (ESI$^+$) calc. for $C_{11}H_{14}NO$ $[MH]^+$ 176.1070, found 176.1072.


114

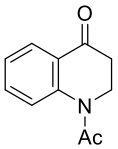
The title compound (**114**) was obtained as a colourless solid (0.3 mg, 1% yield) using the described general method [from **113** (0.20 mmol) and the variant R19/F87A/A328I (0.10 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (400 MHz, CD_3OD) δ 7.38–7.31 (m, 1H), 7.28–7.13 (m, 3H), 4.47 (t, *J* = 5.4 Hz, 1H), 2.69 (t, *J* = 7.8 Hz, 2H), 2.22 (t, *J* = 9.8 Hz, 1H), 2.16 (s, 2H), 1.81 (dd, *J* = 7.8, 5.5 Hz, 1H) ppm. HRMS (ESI$^+$) calc. for $C_{11}H_{14}NO_2$ $[MH]^+$ 192.1019, found 192.1018.


115

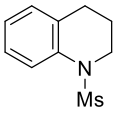
The title compound (**115**)[59] was obtained as a white solid (12.0 mg, 31% yield) using the described general method [from **113** (0.20 mmol) and the variant R19/F87A/A328I (0.10 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (500 MHz, CD_3OD) δ 7.48 (dd, *J* = 7.5 Hz, 1.4 Hz, 1H), 7.39 (br s, 1H), 7.28 (t, *J* = 7.4 Hz, 1H), 7.22 (t, *J* = 7.6 Hz, 1H), 4.71 (t, *J* = 5.6 Hz, 1H), 4.00 (dd, *J* = 13.1 Hz, 6.7 Hz, 1H), 3.73–3.60 (m, 1H), 2.24 (s, 3H), 2.19 (dddd, *J* = 13.5 Hz, 7.6 Hz, 6.0 Hz, 4.9 Hz, 1H), 1.99–1.85 (m, 1H) ppm. ^{13}C NMR (125 MHz, CD_3OD) δ 171.2, 127.1, 124.2, 65.0, 47.9, 32.7 ppm. HRMS (ESI$^+$) calc. for $C_{11}H_{14}NO_2$ $[MH]^+$ 192.1019, found 192.1020.


116

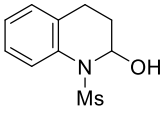
The title compound (**116**)[60] was obtained as a colourless solid (1.0 mg, 3% yield) using the described general method [from **113** (0.20 mmol) and the variant R19/F87A/A328I (0.10 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (500 MHz, CD_3OD) δ 7.97 (dt, *J* = 7.8, 1.2 Hz, 1H), 7.69–7.57 (m, 2H), 7.32 (t, *J* = 8.0 Hz, 1H), 4.23 (d, *J* = 4.3 Hz, 2H), 2.35 (s, 3H), 1.43–1.21 (m, 2H), 0.90 (dd, *J* = 11.4, 4.4 Hz, 2H) ppm. HRMS (ESI$^+$) calc. for $C_{11}H_{16}NO_2$ $[MH]^+$ 194.1176, found 194.1178.


117

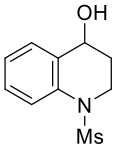
The title compound (**117**)[61] was obtained as a white solid (0.8 mg, 8% yield) using the described general method [from **113** (0.05 mmol) and the variant R19/F87A/A328I (0.10 μmol) in phosphate buffer, 10.0 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (500 MHz, CD_3OD) δ 7.97 (dt, *J* = 7.8 Hz, 1.1 Hz, 1H), 7.70–7.56 (m, 2H), 7.32 (t, *J* = 8.0 Hz, 1H), 4.23 (t, *J* = 6.2 Hz, 2H), 2.86–2.75 (m, 2H), 2.35 (s, 3H) ppm. HRMS (ESI$^+$) calc. for $C_{11}H_{12}NO_2$ $[MH]^+$ 190.0863, found 190.0865.


118

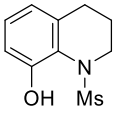
To a solution of **13** (1.000g, 7.519 mmol) and DMAP (730.0 μL, 9.023 mmol) in 45.0 mL DCM at 0 ºC, mesyl chloride (1.034 g, 9.023 mmol) in 5.00 mL DCM was added dropwise. The mixture was stirred at ambient temperature for 2 hours and then washed with 100 mL saturated $NaHCO_3$, 100 mL 2 M HCl and 100 mL brine, then dried over anhydrous Na_2SO_4. The organic layer was then concentrated *in vacuo* and purified by silica gel chromatography (petrol/EtOAc, 1:1) to give **118**[62] (672.3 mg, 42% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.70 (dd, *J* = 8.3, 1.2 Hz, 1H), 7.18 (dddd, *J* = 7.9, 7.0, 1.8, 0.9 Hz, 1H), 7.15–7.11 (m, 1H), 7.10–7.04 (m, 1H), 3.86–3.78 (m, 2H), 2.90 (s, 3H), 2.86 (t, *J* = 6.7 Hz, 2H), 2.06–1.95 (m, 2H) ppm. ^{13}C NMR (101 MHz, $CDCl_3$) δ 137.07, 129.86, 129.23, 127.01, 124.69, 122.84, 46.64, 38.79, 27.24, 22.38 ppm. HRMS (ESI$^+$) calc. for $C_{10}H_{13}NO_2SNa$ $[MNa]^+$ 234.0560, found 234.0560.


119

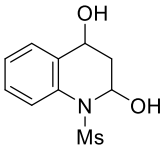
The title compound (**119**) was obtained as an orange solid (12.3 mg, 53% yield) using the described general method [from **118** (0.10 mmol) and the variant R19/F87A/I263G (0.10 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (400 MHz, CD_3OD) δ 7.63 (dd, *J* = 8.7, 1.2 Hz, 1H), 7.22–7.15 (m, 2H), 7.06 (td, *J* = 7.4, 1.2 Hz, 1H), 5.93 (t, *J* = 4.9 Hz, 1H), 3.03 (s, 3H), 2.94–2.85 (m, 1H), 2.71–2.61 (m, 1H), 2.24–2.13 (m, 1H), 1.91 (ddt, *J* = 13.4, 6.9, 5.3 Hz, 1H) ppm. ^{13}C NMR (101 MHz, CD_3OD) δ 136.77, 131.61, 129.85, 127.86, 125.19, 122.94, 79.83, 40.08, 31.78, 24.12 ppm. HRMS (ESI$^+$) calc. for $C_{10}H_{14}NO_3SNa$ $[MNa]^+$ 250.0509, found 250.0510.


120

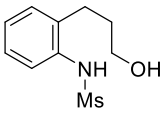
The title compound (**120**) was obtained as an yellow solid (18.2 mg, 78% yield) using the described general method [from **118** (0.10 mmol) and the variant R19/F87A/A328L (0.10 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.77 (ddd, *J* = 8.4, 1.1, 0.6 Hz, 1H), 7.40 (ddt, *J* = 7.6, 1.7, 0.6 Hz, 1H), 7.30 (ddd, *J* = 8.3, 7.3, 1.7 Hz, 1H), 7.15 (td, *J* = 7.5, 1.2 Hz, 1H), 4.83 (t, *J* = 4.1 Hz, 1H), 4.10–4.03 (m, 1H), 3.80–3.71 (m, 1H), 2.92 (s, 3H), 2.13–2.09 (m, 2H) ppm. ^{13}C NMR (101 MHz, $CDCl_3$) δ 136.52, 130.18, 129.79, 129.44, 124.59, 121.72, 65.42, 41.94, 38.32, 30.76 ppm. HRMS (ESI$^+$) calc. for $C_{10}H_{14}NO_3SNa$ $[MNa]^+$ 250.0509, found 250.0509.


121

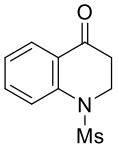
The title compound (**121**) was obtained as a white solid (1.2 mg, 5% yield) using the described general method [from **118** (0.10 mmol) and the variant K19/A82M/F87A (0.10 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.10 (s, 1H), 7.53 (dd, *J* = 8.0, 1.3 Hz, 1H), 7.24–7.20 (m, 1H), 7.18–7.14 (m, 1H), 3.59 (t, *J* = 5.6 Hz, 2H), 2.98 (s, 3H), 2.85–2.79 (m, 2H), 1.92–1.83 (m, 2H) ppm. HRMS (ESI$^+$) calc. for $C_{10}H_{14}NO_3SNa$ $[MNa]^+$ 250.0509, found 250.0509.


122

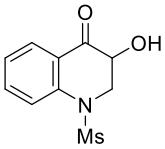
The title compound (**122**) was obtained as a yellow solid (0.8 mg, 3% yield) using the described general method [from **118** (0.10 mmol) and the variant K19/A82M/F87A (0.10 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (400 MHz, CD_3OD) δ 7.60 (d, *J* = 8.4 Hz, 1H), 7.49 (d, *J* = 7.9 Hz, 1H), 7.27 (d, *J* = 7.6 Hz, 1H), 7.20 (t, *J* = 7.6 Hz, 1H), 5.96 (t, *J* = 6.0 Hz, 1H), 4.66 (dd, *J* = 8.5, 4.2 Hz, 1H), 3.07 (s, 3H), 2.55 (dt, *J* = 13.3, 5.1 Hz, 1H), 2.02–1.94 (m, 1H) ppm. HRMS (ESI$^+$) calc. for $C_{10}H_{14}NO_4S$ $[MH]^+$ 244.0639, found 244.0640.


123

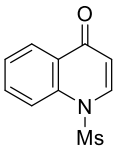
The title compound (**123**) was obtained as a white solid (1.4 mg, 6% yield) using the described general method [from **118** (0.10 mmol) and the variant K19/A82M/F87A (0.10 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (400 MHz, MeOD) δ 7.40–7.36 (m, 1H), 7.31–7.19 (m, 3H), 3.56 (t, *J* = 6.3 Hz, 2H), 2.98 (s, 3H), 2.85–2.80 (m, 2H), 1.88–1.80 (m, 2H) ppm. HRMS (ESI$^+$) calc. for $C_{10}H_{16}NO_3S$ $[MH]^+$ 230.0846, found 230.0844.


124

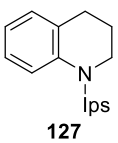
The title compound (**124**)[63] was obtained as a white solid (5.0 mg, 21% yield) using the described general method [from **118** (0.10 mmol) and the variant K19/F87V (0.10 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.07 (dd, *J* = 7.9, 1.8 Hz, 1H), 7.75 (dd, *J* = 8.5, 1.0 Hz, 1H), 7.57 (ddd, *J* = 8.6, 7.3, 1.8 Hz, 1H), 7.30–7.22 (m, 1H), 4.25–4.17 (m, 2H), 3.07 (s, 3H), 2.89–2.85 (m, 2H) ppm. HRMS (ESI$^+$) calc. for $C_{10}H_{11}NO_3SNa$ $[MNa]^+$ 248.0352, found 248.0351.


125

The title compound (**125**) was obtained as a white solid (1.2 mg, 5% yield) using the described general method [from **118** (0.10 mmol) and the variant K19/F87V (0.10 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.08 (dd, *J* = 7.8, 1.9 Hz, 1H), 7.80 (d, *J* = 8.6 Hz, 1H), 7.61 (ddd, *J* = 8.7, 7.2, 1.7 Hz, 1H), 7.29–7.24 (m, 1H), 4.68 (dd, *J* = 12.7, 5.8 Hz, 2H), 4.58 (ddd, *J* = 12.5, 5.8, 2.0 Hz, 1H), 3.63 (t, *J* = 12.6 Hz, 2H), 3.58 (d, *J* = 2.1 Hz, 1H), 3.14 (s, 3H) ppm. HRMS (ESI$^+$) calc. for $C_{10}H_{12}NO_4S$ $[MH]^+$ 242.0482, found 242.0480.

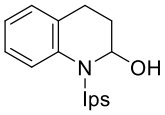

126

The title compound (**126**)[64] was obtained as a colourless oil (4.5 mg, 19% yield) using the described general method [from **118** (0.10 mmol) and the variant R19/F87A/A184I (0.10 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.45 (ddd, *J* = 8.0, 1.8, 0.5 Hz, 1H), 8.29 (d, *J* = 8.6 Hz, 1H), 8.26 (dt, *J* = 8.8, 0.8 Hz, 1H), 7.76 (ddd, *J* = 8.8, 7.1, 1.8 Hz, 1H), 7.52 (ddd, *J* = 8.1, 7.1, 0.9 Hz, 1H), 6.36 (d, *J* = 8.6 Hz, 1H), 3.37 (s, 3H) ppm. HRMS (ESI$^+$) calc. for $C_{10}H_{10}NO_3S$ $[MH]^+$ 224.0376, found 224.0374.


127

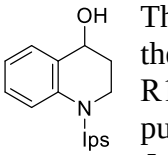
To a solution of **13** (1.000g, 7.519 mmol) and DMAP (730.0 μL, 9.023 mmol) in 45.0 mL DCM at 0 ºC, isopropylsofonyl chloride (1.281 g, 9.023 mmol) in 5.00 mL DCM was added dropwise. The mixture was stirred at ambient temperature for 16 hours and then washed with 100 mL saturated $NaHCO_3$, 100 mL 2 M HCl and 100 mL brine, then dried over anhydrous Na_2SO_4. The organic layer was then concentrated *in vacuo* and purified by silica gel chromatography (petrol/EtOAc, 2:1) to give **127** (342.6 mg, 42% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.60–7.56 (m, 1H), 7.15–7.08 (m, 2H), 7.00 (td, *J* = 7.4,

1.2 Hz, 1H), 3.81–3.74 (m, 2H), 3.47 (p, *J* = 6.9 Hz, 1H), 2.84 (t, *J* = 6.7 Hz, 2H), 2.08–1.95 (m, 2H), 1.37 (d, *J* = 6.8 Hz, 6H) ppm. ^{13}C NMR (101 MHz, $CDCl_3$) δ 137.58, 129.78, 128.34, 126.57, 123.53, 121.22, 53.58, 47.01, 27.26, 23.04, 16.66 ppm. HRMS (ESI^+) calc. for $C_{12}H_{18}NO_2S$ $[MH]^+$ 240.1053, found 240.1053.



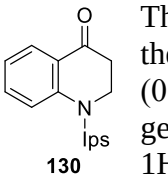
128

The title compound (**128**) was obtained as a white solid (4.2 mg, 18% yield) using the described general method [from **127** (0.10 mmol) and the variant R19/F87A/A328G (0.10 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.73 (dd, *J* = 8.3, 1.1 Hz, 1H), 7.19 (ddd, *J* = 8.2, 7.3, 1.7 Hz, 1H), 7.16–7.13 (m, 1H), 7.03 (td, *J* = 7.4, 1.2 Hz, 1H), 5.85 (ddd, *J* = 5.9, 4.9, 3.6 Hz, 1H), 3.51 (dd, *J* = 3.7, 0.9 Hz, 1H), 3.49–3.42 (m, 1H), 2.87 (ddd, *J* = 15.6, 8.9, 4.3 Hz, 1H), 2.62 (ddd, *J* = 15.5, 8.3, 4.1 Hz, 1H), 2.20–2.10 (m, 1H), 2.01 (dddd, *J* = 13.6, 8.3, 5.8, 4.3 Hz, 1H), 1.33 (dd, *J* = 6.9, 1.5 Hz, 6H) ppm. HRMS (ESI^+) calc. for $C_{12}H_{17}NO_3SNa$ $[MNa]^+$ 278.0822, found 278.0822.



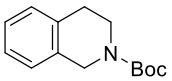
129

The title compound (**129**) was obtained as a white solid (7.2 mg, 30% yield) using the described general method [from **127** (0.10 mmol) and the variant R19/F87A/A328L (0.10 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.64 (dd, *J* = 8.5, 1.1 Hz, 1H), 7.39 (dt, *J* = 7.6, 1.1 Hz, 1H), 7.26 (td, *J* = 7.7, 1.8 Hz, 1H), 7.09 (td, *J* = 7.4, 1.1 Hz, 1H), 4.81 (t, *J* = 4.1 Hz, 1H), 4.07 (dtd, *J* = 12.9, 4.4, 0.5 Hz, 1H), 3.73 (ddd, *J* = 13.0, 8.7, 5.6 Hz, 1H), 3.52 (hept, *J* = 6.8 Hz, 1H), 2.11 (ddd, *J* = 2068.8, 9.3, 4.4 Hz, 2H), 1.39 (t, *J* = 6.7 Hz, 6H) ppm. ^{13}C NMR (101 MHz, $CDCl_3$) δ 137.36, 130.32, 129.54, 129.40, 123.96, 120.78, 65.70, 54.05, 42.84, 31.55, 17.00 (d, *J* = 11.8 Hz) ppm. HRMS (ESI^+) calc. for $C_{12}H_{17}NO_3SNa$ $[MNa]^+$ 278.0822, found 278.0822.



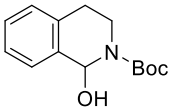
130

The title compound (**130**) was obtained as a white solid (2.8 mg, 12% yield) using the described general method [from **127** (0.10 mmol) and the variant K19/F87V (0.10 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.05 (ddd, *J* = 7.9, 1.7, 0.5 Hz, 1H), 7.65 (ddd, *J* = 8.5, 1.1, 0.5 Hz, 1H), 7.52 (ddd, *J* = 8.4, 7.2, 1.8 Hz, 1H), 7.20 (ddd, *J* = 8.3, 7.2, 1.1 Hz, 1H), 4.22–4.14 (m, 2H), 3.52 (dt, *J* = 13.7, 6.8 Hz, 1H), 2.91 – 2.84 (m, 2H), 1.45 (d, *J* = 6.8 Hz, 7H) ppm. HRMS (ESI^+) calc. for $C_{12}H_{15}NO_3SNa$ $[MNa]^+$ 276.0665, found 276.0665.



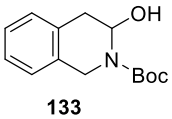
131

To a solution of 1,2,3,4-tetrahydroisoquinoline (931.0 mg, 7.000 mmol) in 65.0 mL anhydrous tetrahydrofuran was added triethylamine (1.100 mL, 7.892 mmol). Di-tert-butyl-dicarbonate (1.987 g, 9.100 mmol) dissolved in 5.00 mL anhydrous tetrahydrofuran was added slowly so that the temperature was maintained below 32 ºC and the mixture was stirred at ambient temperature for 2 hours. Tetrahydrofuran was removed *in vacuo*, and the crude was extracted by ethyl acetate (3 × 100 mL) and dried by anhydrous Na_2SO_4. The combined organic layers were purified by silica gel chromatography (petrol/EtOAc, 1:1) to afford a pale yellow oil **131**[65] (694.5 mg, 43%). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.23–7.07 (m, 4H), 4.57 (s, 2H), 3.65 (t, *J* = 5.9 Hz, 2H), 2.83 (t, *J* = 5.9 Hz, 2H), 1.49 (s, 9H) ppm. HRMS (ESI^+) calc. for $C_{14}H_{20}NO_2$ $[MH]^+$ 234.1489, found 234.1489.



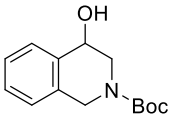
132

The title compound (**132**)[66] was obtained as a yellow oil (6.2 mg, 13% yield) using the described general method [from **131** (0.20 mmol) and the variant R19/F87A/I263G (0.10 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (500 MHz, $CDCl_3$) δ 8.16 (d, *J* = 7.8 Hz, 1H), 7.47 (t, *J* = 7.4 Hz, 1H), 7.35 (t, *J* = 7.6 Hz, 1H), 7.21 (d, *J* = 7.6 Hz, 2H), 7.08 (br s, 1H), 4.00 (t, *J* = 6.2 Hz, 2H), 3.01 (t, *J* = 6.2 Hz, 2H), 1.59 (s, 9H) ppm. HRMS (ESI$^+$) calc. for $C_{14}H_{20}NO_3$ $[MH]^+$ 250.1438, found 250.1435.



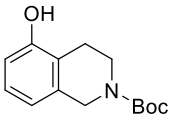
133

The title compound (**133**)[66] was obtained as a yellow oil (2.2 mg, 5% yield) using the described general method [from **131** (0.20 mmol) and the variant R19/F87A/A264G/A328G (0.10 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.28 (t, *J* = 3.5 Hz, 1H), 7.25–7.17 (m, 3H), 5.79 (s, 1H), 4.51 (q, *J* = 15.7 Hz, 2H), 3.09 (dd, *J* = 15.4, 4.4 Hz, 1H), 2.97 (dd, *J* = 15.5, 4.5 Hz, 1H), 1.52 (s, 9H) ppm. HRMS (ESI$^+$) calc. for $C_{14}H_{20}NO_3$ $[MH]^+$ 250.1438, found 250.1436.



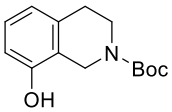
134

The title compound (**134**)[67] was obtained as a yellow oil (9.3 mg, 20% yield) using the described general method [from **131** (0.20 mmol) and the variant K19/F87V (0.10 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.46 (dd, *J* = 6.7, 2.4 Hz, 1H), 7.29–7.26 (m, 2H), 7.15–7.11 (m, 1H), 4.75 (s, 2H), 4.45 (d, *J* = 17.0 Hz, 1H), 3.90 (ddd, *J* = 13.4, 4.9, 0.7 Hz, 1H), 3.60 (dd, *J* = 13.4, 3.5 Hz, 1H), 1.50 (s, 9H) ppm. HRMS (ESI$^+$) calc. for $C_{14}H_{20}NO_3$ $[MH]^+$ 250.1438, found 250.1438.



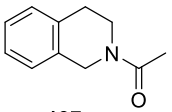
135

The title compound (**135**)[68] was obtained as a white solid (4.1 mg, 9% yield) using the described general method [from **131** (0.20 mmol) and the variant R1/V78I/I263G/L437LV (0.10 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.05 (t, *J* = 7.9 Hz, 1H), 6.70 (d, *J* = 7.7 Hz, 1H), 6.64 (d, *J* = 8.1 Hz, 1H), 4.90 (s, 1H), 4.56 (s, 2H), 3.67 (s, 2H), 2.75 (t, *J* = 6.0 Hz, 2H), 1.49 (s, 9H) ppm. HRMS (ESI$^+$) calc. for $C_{14}H_{20}NO_3$ $[MH]^+$ 250.1438, found 250.1438.



136

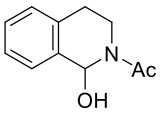
The title compound (**136**)[56] was obtained as a white solid (3.8 mg, 8% yield) using the described general method [from **131** (0.20 mmol) and the variant R1/V78I/I263G/L437LV (0.10 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (500 MHz, $CDCl_3$) δ 6.98 (dd, *J* = 13.6, 8.3 Hz, 1H), 6.69–6.66 (m, 1H), 6.63–6.57 (m, 1H), 4.50 (d, *J* = 10.2 Hz, 2H), 3.61 (d, *J* = 4.8 Hz, 2H), 2.79–2.75 (m, 2H), 1.49 (s, 9H) ppm. HRMS (ESI$^+$) calc. for $C_{14}H_{20}NO_3$ $[MH]^+$ 250.1438, found 250.1439.



137

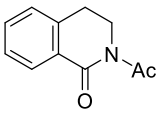
To a solution of 1,2,3,4-tetrahydroisoquinoline (1.000g, 7.519 mmol) and pyridine (730.0 μL, 9.023 mmol) in 45.0 mL DCM at 0 ºC, acetyl chloride (644.0 μL, 9.023 mmol) in 5.00 mL DCM was added dropwise. The mixture was stirred at ambient temperature for 1 hours and then washed with 100 mL saturated $NaHCO_3$, 100 mL 2 M HCl and 100 mL brine, then dried over anhydrous Na_2SO_4. The organic layer was then concentrated *in vacuo* and purified by silica gel chromatography to give **137**[69] (982.3 mg, 75% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.20–7.13 (m, 4 H), 4.72 (major rotamer, s, 1.15 H), 4.61 (minor rotamer, 0.85 H), 3.81 (minor rotamer, t, *J* = 6.0 Hz, 0.85 H), 3.67 (major rotamer, t, *J* = 6.0 Hz, 1.12 H), 2.91 (major rotamer, t, *J* = 5.8 Hz, 1.17 H), 2.85 (minor rotamer, t, *J* = 6.0 Hz, 0.82 H), 2.18 (minor rotamer, s, 1.42 H), 2.17 (major

rotamer, s, 1.61 H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$) δ 169.65 (major rotamer), 169.56 (minor rotamer), 135.10 (minor rotamer), 134.04 (major rotamer), 133.50 (major rotamer), 132.55 (minor rotamer), 128.97 (minor rotamer), 128.31 (major rotamer), 126.95 (minor rotamer), 126.69 (major rotamer), 126.65 (major rotamer), 126.57 (minor rotamer), 126.39 (major rotamer), 126.06 (minor rotamer), 48.10 (minor rotamer), 44.12 (major rotamer), 44.04 (major rotamer), 39.53 (minor rotamer), 29.46 (major rotamer), 28.53 (minor rotamer), 21.97 (minor rotamer), 21.70 (major rotamer) ppm. HRMS (ESI^+) calc. for $C_{11}H_{14}NO$ $[MH]^+$ 176.1070, found 176.1071.



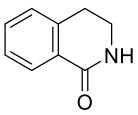
138

The title compound (**138**) was obtained as a white solid (3.8 mg, 11% yield) using the described general method [from **137** (0.20 mmol) and the variant K19/F87V (0.10 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.26 (s, 3H), 7.18 (d, *J* = 7.3 Hz, 1H), 5.76 (s, 1H), 3.86 (dddd, *J* = 13.2, 6.1, 3.0, 0.9 Hz, 1H), 3.62 (ddd, *J* = 13.3, 11.4, 4.7 Hz, 1H), 3.10–2.97 (m, 1H), 2.91 (s, 3H), 2.90–2.83 (m, 1H) ppm. HRMS (ESI^+) calc. for $C_{11}H_{14}NO_2$ $[MH]^+$ 192.1019, found 192.1020.



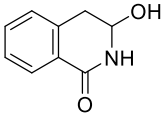
139

The title compound (**139**)[70] was obtained as a white solid (6.4 mg, 18% yield) using the described general method [from **137** (0.20 mmol) and the variant K19/F87V (0.10 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.15 (dd, *J* = 7.8, 1.4 Hz, 1H), 7.51 (td, *J* = 7.4, 1.4 Hz, 1H), 7.45–7.33 (m, 1H), 7.25 (d, *J* = 7.7 Hz, 1H), 4.15–4.07 (m, 2H), 2.99 (t, *J* = 6.3 Hz, 2H), 2.67 (s, 3H) ppm. ^{13}C NMR (101 MHz, $CDCl_3$) δ 173.91, 165.92, 140.41, 133.55, 129.68, 129.18, 127.52, 41.88, 28.28, 27.78 ppm. HRMS (ESI^+) calc. for $C_{11}H_{12}NO_2$ $[MH]^+$ 190.0863, found 190.0864.



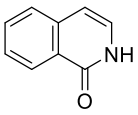
140

The title compound (**140**)[71] was obtained as a white solid (1.2 mg, 3% yield) using the described general method [from **137** (0.20 mmol) and the variant K19/F87V (0.10 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.07 (dt, *J* = 7.7, 1.6 Hz, 1H), 7.45 (tt, *J* = 7.5, 1.6 Hz, 2H), 7.36 (dd, *J* = 8.4, 6.8 Hz, 1H), 7.22 (d, *J* = 7.5 Hz, 1H), 6.08 (s, 1H), 3.58 (tdd, *J* = 6.9, 2.9, 1.5 Hz, 2H), 3.01 (t, *J* = 6.5 Hz, 2H) ppm. ^{13}C NMR (101 MHz, $CDCl_3$) δ 166.38, 138.95, 132.35, 128.22, 127.39, 127.26, 40.45, 28.53 ppm. HRMS (ESI^+) calc. for $C_9H_{10}NO$ $[MH]^+$ 148.0757, found 148.0754.



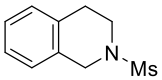
141

The title compound (**141**) was obtained as a white solid (1.2 mg, 3% yield) using the described general method [from **137** (0.20 mmol) and the variant K19/F87V (0.10 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.19 (dd, *J* = 8.1, 1.4 Hz, 1H), 7.69–7.60 (m, 2H), 7.56–7.48 (m, 2H), 4.96 (s, 2H), 4.33 (dd, *J* = 13.6, 6.0 Hz, 2H), 4.05 (dd, *J* = 13.6, 3.4 Hz, 1H), 2.70 (s, 6H) ppm. HRMS (ESI^+) calc. for $C_9H_{10}NO_2$ $[MH]^+$ 164.0707, found 164.0706.



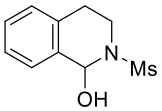
142

The title compound (**142**)[72] was obtained as a white solid (0.8 mg, 1% yield) using the described general method [from **137** (0.20 mmol) and the variant K19/F87V (0.10 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (400 MHz,$CDCl_3$) δ 8.41 (d, *J* = 8.0 Hz, 1H), 7.68 (ddd, *J* = 8.2, 7.1, 1.3 Hz, 1H), 7.56 (dd, *J* = 7.8, 1.1 Hz, 1H), 7.51 (ddd, *J* = 8.3, 7.1, 1.3 Hz, 1H), 7.09 (d, *J* = 7.1 Hz, 1H), 6.61–6.47 (m, 1H) ppm. HRMS (ESI^+) calc. for C_9H_8NO $[MH]^+$ 146.0601, found 146.0600.



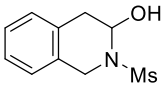
143

To a solution of 1,2,3,4-tetrahydroisquinoline (1.000g, 7.519 mmol) and DMAP (730.0 µL, 9.023 mmol) in 45.0 mL DCM at 0 ºC, mesyl chloride (1.034 g, 9.023 mmol) in 5.00 mL DCM was added dropwise. The mixture was stirred at ambient temperature for 1 hours and then washed with 100 mL saturated $NaHCO_3$, 100 mL 2 M HCl and 100 mL brine, then dried over anhydrous Na_2SO_4. The organic layer was then concentrated *in vacuo* and purified by silica gel chromatography (petrol/EtOAc, 1:1) to give **143**[73] (798.4 mg, 46% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.23 – 7.12 (m, 3H), 7.09 (dd, *J* = 5.1, 3.5 Hz, 1H), 4.46 (s, 2H), 3.57 (t, *J* = 6.0 Hz, 2H), 2.98 (t, *J* = 6.0 Hz, 2H), 2.84 (s, 3H) ppm. ^{13}C NMR (101 MHz, $CDCl_3$) δ 133.27, 131.82, 129.16, 127.13, 126.69, 126.48, 47.40, 43.56, 36.01, 28.82 ppm. HRMS (ESI$^+$) calc. for $C_{10}H_{13}NO_2SNa$ $[MNa]^+$ 234.0560, found 234.0560.



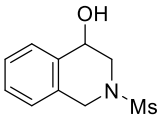
144

The title compound (**144**) was obtained as an orange solid (10.9 mg, 47% yield) using the described general method [from **143** (0.10 mmol) and the variant RT2/V78I/A184I/A330P (0.10 µmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.38–7.35 (m, 1H), 7.31–7.27 (m, 2H), 7.19–7.16 (m, 1H), 6.24 (s, 1H), 3.87 (dddd, *J* = 12.2, 6.0, 2.1, 1.0 Hz, 1H), 3.54–3.40 (m, 1H), 3.12–3.05 (m, 1H), 3.01 (s, 3H), 2.92–2.86 (m, 1H) ppm. HRMS (ESI$^+$) calc. for $C_{10}H_{14}NO_3SNa$ $[MNa]^+$ 250.0509, found 250.0510.



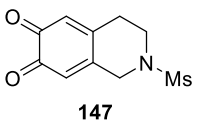
145

The title compound (**145**) was obtained as an orange solid (4.5 mg, 19% yield) using the described general method [from **143** (0.10 mmol) and the variant RP/H171L/I263G (0.10 µmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.31–7.15 (m, 4H), 5.73 (dt, *J* = 5.8, 3.9 Hz, 1H), 4.60 (d, *J* = 15.1 Hz, 1H), 4.45 (d, *J* = 15.0 Hz, 1H), 3.29 (dd, *J* = 15.6, 4.3 Hz, 1H), 2.99 (dd, *J* = 16.2, 3.6 Hz, 1H), 2.91 (s, 3H), 2.70–2.60 (m, 1H) ppm. HRMS (ESI$^+$) calc. for $C_{10}H_{14}NO_3SNa$ $[MNa]^+$ 250.0509, found 250.0509.



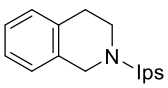
146

The title compound (**146**) was obtained as an orange solid (3.3 mg, 14% yield) using the described general method [from **143** (0.10 mmol) and the variant K19/F87V/Q403P (0.10 µmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.47 (dd, *J* = 5.5, 3.6 Hz, 1H), 7.34–7.30 (m, 2H), 7.14 (dd, *J* = 5.4, 3.6 Hz, 1H), 4.82 (s, 1H), 4.67 (d, *J* = 15.7 Hz, 1H), 4.31 (d, *J* = 15.7 Hz, 1H), 3.89 (ddd, *J* = 13.0, 3.5, 1.3 Hz, 1H), 3.42 (ddd, *J* = 13.2, 3.0, 0.7 Hz, 1H), 2.94 (s, 3H) ppm. HRMS (ESI$^+$) calc. for $C_{10}H_{14}NO_3SNa$ $[MNa]^+$ 250.0509, found 250.0509.



147

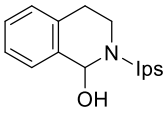
The title compound (**147**) was obtained as an orange solid (0.8 mg, 3% yield) using the described general method [from **143** (0.10 mmol) and the variant RP/H171L/I263G/L437LV (0.10 µmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (400 MHz, MeOD) δ 6.57 (t, *J* = 0.9 Hz, 1H), 6.53 (t, *J* = 0.9 Hz, 1H), 4.25 (d, *J* = 1.0 Hz, 2H), 3.46 (t, *J* = 6.0 Hz, 3H), 2.86 (s, 3H), 2.82–2.76 (m, 2H) ppm. HRMS (ESI$^+$) calc. for $C_{10}H_{12}NO_4S$ $[MH]^+$ 242.0482, found 242.0482.



148

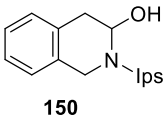
To a solution of 1,2,3,4-tetrahydroisoquinoline (1.000g, 7.519 mmol) and DMAP (730.0 µL, 9.023 mmol) in 45.0 mL DCM at 0 ºC, isopropylsofonyl chloride (1.281 g, 9.023 mmol) in 5.00 mL DCM was added dropwise. The mixture was stirred at ambient temperature for 1 hours and then washed with

100 mL saturated $NaHCO_3$, 100 mL 2 M HCl and 100 mL brine, then dried over anhydrous Na_2SO_4. The organic layer was then concentrated *in vacuo* and purified by silica gel chromatography to give **148** (890.2 mg, 50% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.20–7.12 (m, 3H), 7.06 (dd, *J* = 5.2, 3.5 Hz, 1H), 4.53 (s, 2H), 3.63 (t, *J* = 5.9 Hz, 2H), 3.25 (hept, *J* = 6.9 Hz, 1H), 2.98–2.90 (m, 2H), 1.36 (d, *J* = 6.9 Hz, 6H) ppm. ^{13}C NMR (101 MHz, $CDCl_3$) δ 133.62, 132.58, 129.24, 126.90, 126.51, 126.26, 53.58 (d, *J* = 3.3 Hz), 47.66, 43.96, 29.52, 16.86 ppm. HRMS (ESI$^+$) calc. for $C_{12}H_{18}NO_2S$ $[MH]^+$ 240.1053, found 240.1053.



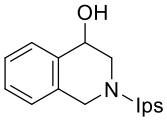
149

The title compound (**149**) was obtained as a white solid (1.2 mg, 5% yield) using the described general method [from **148** (0.10 mmol) and the variant I263G (0.10 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (400 MHz, CD_3OD) δ 7.35 (dd, *J* = 5.1, 4.0 Hz, 1H), 7.27–7.25 (m, 2H), 7.20–7.17 (m, 1H), 6.06 (s, 1H), 3.89 (dddd, *J* = 13.1, 6.0, 2.0, 1.1 Hz, 1H), 3.59–3.54 (m, 1H), 3.44 (hept, *J* = 6.8 Hz, 1H), 2.94 (dt, *J* = 16.6, 5.2 Hz, 1H), 2.82 (ddd, *J* = 16.4, 3.8, 2.0 Hz, 1H), 1.35 (dd, *J* = 22.6, 6.8 Hz, 6H) ppm. HRMS (ESI$^+$) calc. for $C_{12}H_{17}NO_3SNa$ $[MNa]^+$ 278.0822, found 278.0822.



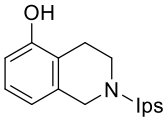
150

The title compound (**150**) was obtained as a white solid (1.0 mg, 4% yield) using the described general method [from **148** (0.10 mmol) and the variant I263G (0.10 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (400 MHz, CD_3OD) δ 7.14–7.02 (m, 4H), 5.57 (dd, *J* = 4.5, 2.5 Hz, 1H), 4.44 (d, *J* = 2.0 Hz, 2H), 3.30–3.22 (m, 1H), 3.11 (dd, *J* = 16.5, 4.4 Hz, 1H), 2.86–2.79 (m, 1H), 1.22 (dd, *J* = 8.3, 6.8 Hz, 6H) ppm.HRMS (ESI$^+$) calc. for $C_{12}H_{17}NO_3SNa$ $[MNa]^+$ 278.0822, found 278.0822.



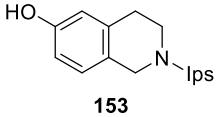
151

The title compound (**151**) was obtained as a white solid (5.2 mg, 22% yield) using the described general method [from **148** (0.10 mmol) and the variant I263G (0.10 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.48 (dd, *J* = 5.3, 3.8 Hz, 1H), 7.32–7.28 (m, 2H), 7.11 (dd, *J* = 5.3, 3.7 Hz, 1H), 4.77 (t, *J* = 3.6 Hz, 1H), 4.72–4.67 (m, 1H), 4.42 (dd, *J* = 16.0, 0.8 Hz, 1H), 3.85 (ddd, *J* = 13.6, 4.0, 1.3 Hz, 1H), 3.57 (ddd, *J* = 13.5, 3.3, 0.8 Hz, 1H), 3.36 (hept, *J* = 6.5 Hz, 1H), 1.39 (dd, *J* = 15.3, 6.8 Hz, 6H) ppm. HRMS (ESI$^+$) calc. for $C_{12}H_{17}NO_3SNa$ $[MNa]^+$ 278.0822, found 278.0822.



152

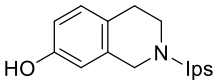
The title compound (**152**) was obtained as a white solid (2.4 mg, 10% yield) using the described general method [from **148** (0.10 mmol) and the variant I263G (0.10 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.06 (t, *J* = 7.8 Hz, 1H), 6.67 (d, *J* = 7.3 Hz, 1H), 6.65 (d, *J* = 8.2 Hz, 1H), 4.84 (s, 1H), 4.51 (s, 2H), 3.65 (t, *J* = 6.0 Hz, 2H), 3.25 (hept, *J* = 6.9 Hz, 1H), 2.84 (t, *J* = 6.2 Hz, 2H), 1.35 (d, *J* = 1.4 Hz, 6H) ppm. HRMS (ESI$^+$) calc. for $C_{12}H_{17}NO_3SNa$ $[MNa]^+$ 278.0822, found 278.0822.



153

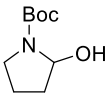
The title compound (**153**) was obtained as a white solid (0.6 mg, 3% yield) using the described general method [from **148** (0.10 mmol) and the variant I263G (0.10 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.01 (d, *J* = 8.3 Hz, 1H), 6.69–6.66 (m, 1H), 6.54 (d, *J* = 2.7 Hz, 1H), 4.74 (s, 1H), 4.47 (s, 2H),

3.61 (t, *J* = 5.9 Hz, 2H), 3.25 (hept, *J* = 6.9 Hz, 1H), 2.84 (t, *J* = 6.2 Hz, 2H), 1.36 (d, *J* = 1.4 Hz, 6H) ppm. HRMS (ESI$^+$) calc. for $C_{12}H_{17}NO_3SNa$ [MNa]$^+$ 278.0822, found 278.0822.



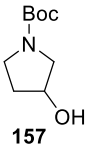
154

The title compound (**154**) was obtained as a white solid (0.7 mg, 3% yield) using the described general method [from **148** (0.10 mmol) and the variant I263G (0.10 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (500 MHz, $CDCl_3$) δ 6.93 (d, *J* = 8.3 Hz, 1H), 6.69–6.66 (m, 1H), 6.62 (d, *J* = 2.7 Hz, 1H), 4.74 (s, 1H), 4.46 (s, 2H), 3.60 (t, *J* = 5.9 Hz, 2H), 3.25 (hept, *J* = 6.9 Hz, 1H), 2.88 (t, *J* = 5.9 Hz, 2H), 1.36 (d, *J* = 1.4 Hz, 6H) ppm. HRMS (ESI$^+$) calc. for $C_{12}H_{17}NO_3SNa$ [MNa]$^+$ 278.0822, found 278.0822.



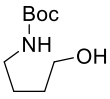
156

The title compound (**156**)[74] was obtained as a colourless oild (11.7 mg, 34% yield) using the described general method [from **155** (0.20 mmol) and the variant R19/F87A (0.10 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (400 MHz, CD_3OD) δ 5.47 (dd, *J* = 17.1, 3.6 Hz, 1H), 3.52 (t, *J* = 9.6 Hz, 1H), 3.41–3.25 (m, 1H), 2.14 (dtq, *J* = 16.6, 12.3, 8.4 Hz, 1H), 1.94 (tdd, *J* = 18.2, 15.9, 8.3, 3.0 Hz, 3H), 1.55 (d, *J* = 3.5 Hz, 9H) ppm. ^{13}C NMR (101 MHz, CD_3OD) δ 156.13, 155.86, 81.97, 81.27, 80.93, 46.89, 46.38, 35.43, 34.61, 28.72, 28.67, 23.42, 22.54 ppm. HRMS (ESI$^+$) calc. for $C_9H_{17}O_3NNa$ [MNa]$^+$ 210.1101, found 210.1102.



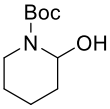
157

The title compound (**157**)[75] was obtained as a colourless oil (3.8 mg, 11% yield) using the described general method [from **155** (0.20 mmol) and the variant RP/H171L/I263G (0.10 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (500 MHz, $CDCl_3$) δ 4.44 (dt, *J* = 4.5, 2.3 Hz, 1H), 3.53–3.26 (m, 4H), 2.12–1.82 (m, 2H), 1.45 (s, 9H) ppm. ^{13}C NMR (126 MHz, $CDCl_3$) δ 154.89, 125.64, 79.48, 71.33, 70.48, 54.48, 54.31, 44.02, 43.58, 33.79, 28.65 ppm. HRMS (ESI$^+$) calc. for $C_9H_{17}O_3NNa$ [MNa]$^+$ 210.1101, found 210.1103.



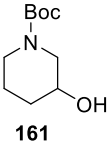
158

The title compound (**158**)[76] was obtained as a colourless oil (4.6 mg, 13% yield) using the described general method [from **155** (0.20 mmol) and the variant R19/F87A (0.10 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (500 MHz, $CDCl_3$) δ 3.67 (t, *J* = 5.8 Hz, 2H), 3.16 (d, *J* = 6.5 Hz, 2H), 1.65–1.52 (m, 4H), 1.44 (s, 9H) ppm. ^{13}C NMR (126 MHz, $CDCl_3$) δ 156.23, 79.33, 62.69, 40.43, 29.87, 28.57, 26.80 ppm. HRMS (ESI$^+$) calc. for $C_9H_{19}O_3NNa$ [MNa]$^+$ 212.1258, found 212.1257.



160

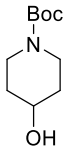
The title compound (**160**)[77] was obtained as a white solid (4.8 mg, 13% yield) using the described general method [from **159** (0.20 mmol) and the variant R19/F87A (0.10 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR ($CDCl_3$, 500 MHz) δ 5.71 (d, *J* = 2.7 Hz, 1H), 3.80 (br d, *J* = 12.9 Hz, 1H), 3.08 (dt, *J* = 3.0, 12.9 Hz, 1H), 1.49–1.94 (m, 6H), 1.44 (s, 9H) ppm. ^{13}C NMR ($CDCl_3$, 126 MHz) δ 155.2, 79.9, 74.2, 38.9, 30.5, 28.2, 24.7, 17.6 ppm. HRMS (ESI$^+$) calc. for $C_{10}H_{19}O_3NNa$ [MNa]$^+$ 224.1258, found 224.1259.



161

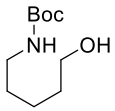
The title compound (**161**)[78] was obtained as a white solid (2.3 mg, 6% yield) using the described general method [from **159** (0.20 mmol) and the variant RP/V78F/F87V/E267V (0.10 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR ($CDCl_3$, 500 MHz) δ 3.72

(m, 2H), 3.54 (m, 1H), 3.10 (m, 2H), 1.90 (m, 1H), 1.79 (m, 2H), 1.47 (m, 9H) ppm. HRMS (ESI^+) calc. for $C_{10}H_{19}O_3NNa$ $[MNa]^+$ 224.1258, found 224.1259.



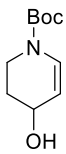
162

The title compound (**162**)[79] was obtained as a white solid (8.9 mg, 24% yield) using the described general method [from **159** (0.20 mmol) and the variant RP/H171L/I263G (0.10 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. ^1H NMR (400 MHz, CD_3OD) δ 3.83 (dd, *J* = 12.4, 5.9 Hz, 2H), 3.78–3.69 (m, 1H), 3.09–2.97 (m, 2H), 1.87–1.76 (m, 2H), 1.45 (d, *J* = 2.1 Hz, 9H), 1.42–1.33 (m, 2H) ppm. ^{13}C NMR (101 MHz, CD_3OD) δ 156.50, 80.99, 68.11, 42.45, 35.00, 28.68 ppm. HRMS (ESI^+) calc. for $C_{10}H_{19}O_3NNa$ $[MNa]^+$ 224.1258, found 224.1260.



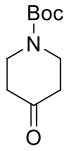
163

The title compound (**163**)[80] was obtained as a colourless oil (4.5 mg, 12% yield) using the described general method [from **159** (0.20 mmol) and the variant R19/F87A (0.10 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. ^1H NMR (500 MHz, CD_3OD) δ 3.55 (t, *J* = 6.6 Hz, 2H), 3.03 (t, *J* = 7.0 Hz, 2H), 1.59–1.45 (m, 6H), 1.43 (s, 9H), 1.41–1.33 (m, 2H) ppm. ^{13}C NMR (126 MHz, CD_3OD) δ 158.54, 79.77, 62.81, 41.30, 33.28, 30.76, 28.79, 24.15 ppm. HRMS (ESI^+) calc. for $C_{10}H_{21}O_3NNa$ $[MNa]^+$ 226.1414, found 226.1414.



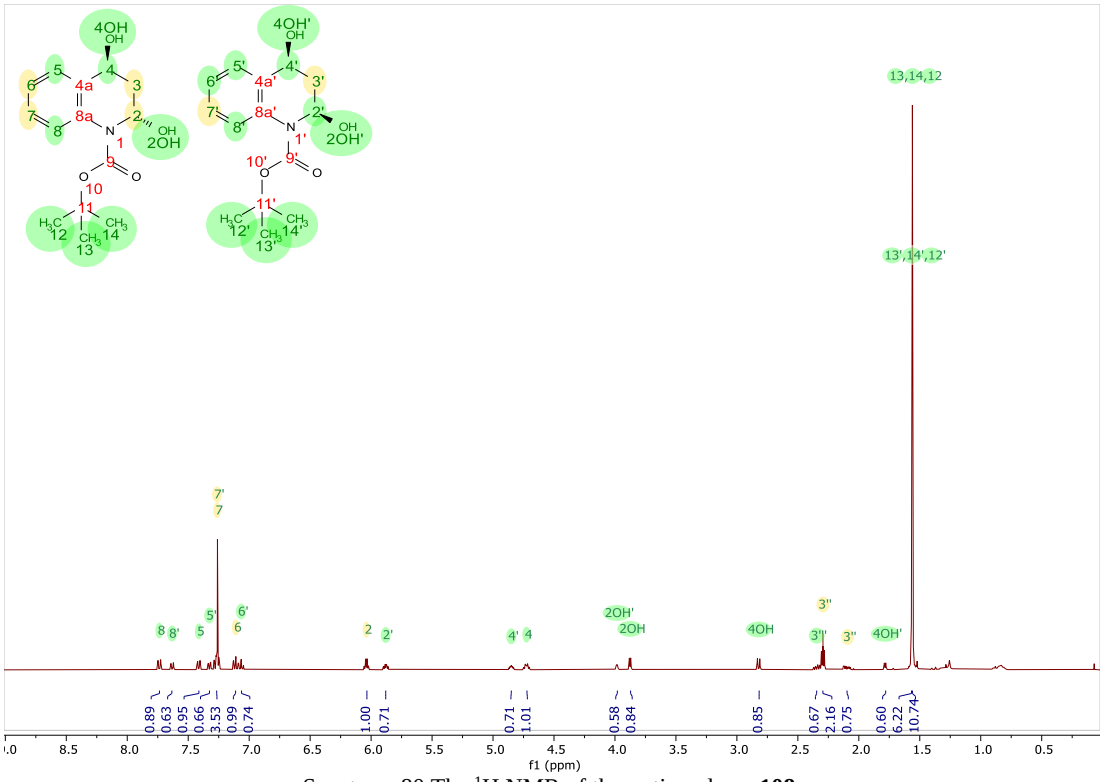
164

The title compound (**164**)[81] was obtained as a colourless oil (2.3 mg, 6% yield) using the described general method [from **159** (0.20 mmol) and the variant K19/F87A/A184I/A328I (0.10 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. ^1H NMR (500 MHz, CD_3OD) δ 6.92–6.79 (m, 1H), 4.99 (d, *J* = 45.5 Hz, 1H), 4.15 (q, *J* = 4.4 Hz, 1H), 3.77 (dt, *J* = 12.9, 4.9 Hz, 1H), 3.37 (dd, *J* = 8.2, 4.7 Hz, 1H), 1.82 (dt, *J* = 8.3, 4.5 Hz, 2H), 1.49 (s, 9H) ppm. ^{13}C NMR (126 MHz, CD_3OD) δ 153.67, 128.07, 108.55, 82.44, 61.63, 38.40, 31.69, 28.47 ppm. HRMS (ESI^+) calc. for $C_{10}H_{18}O_3N$ $[MH]^+$ 200.1282, found 200.1286.

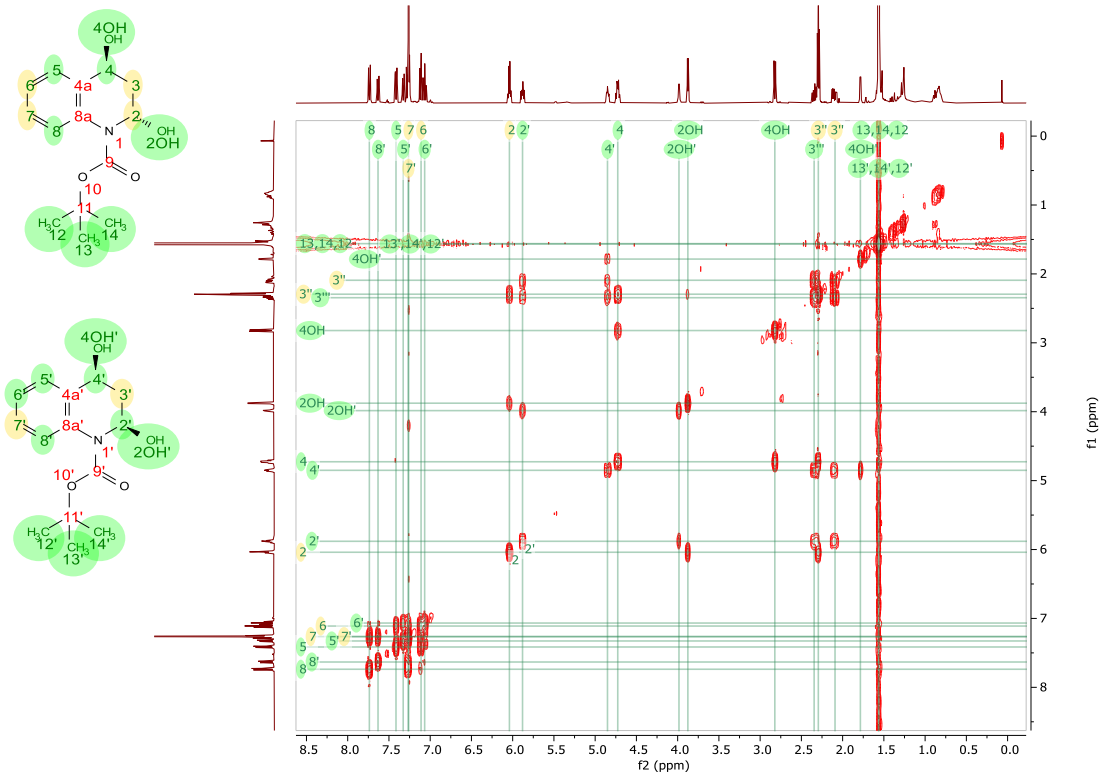


165

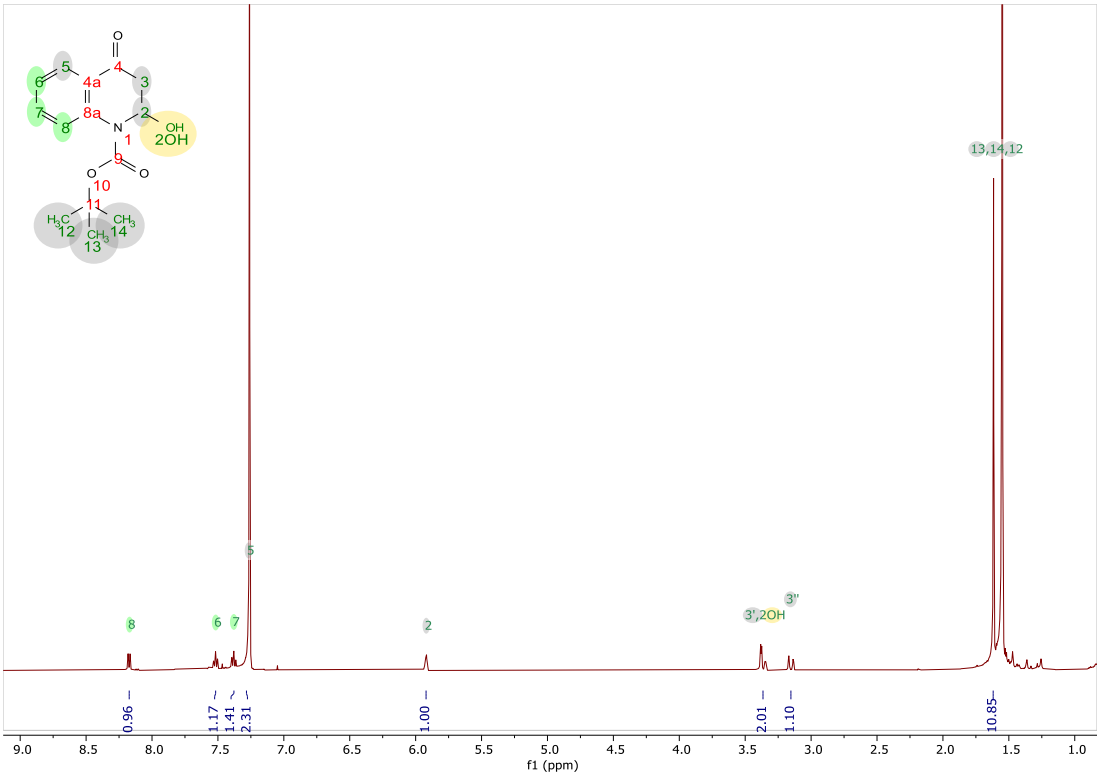
The title compound (**165**)[82] was obtained as a colourless oil (4.0 mg, 11% yield) using the described general method [from **159** (0.20 mmol) and the variant RP/F87V (0.10 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. ^1H NMR (500 MHz, $CDCl_3$) δ 3.72 (t, *J* = 6.2 Hz, 4H), 2.44 (t, *J* = 6.2 Hz, 4H), 1.49 (s, 9H) ppm. ^{13}C NMR (126 MHz, $CDCl_3$) δ 208.00, 154.63, 80.61, 43.24, 41.33, 28.52 ppm. HRMS (ESI^+) calc. for $C_{10}H_{18}O_3N$ $[MH]^+$ 200.1282, found 200.1282.



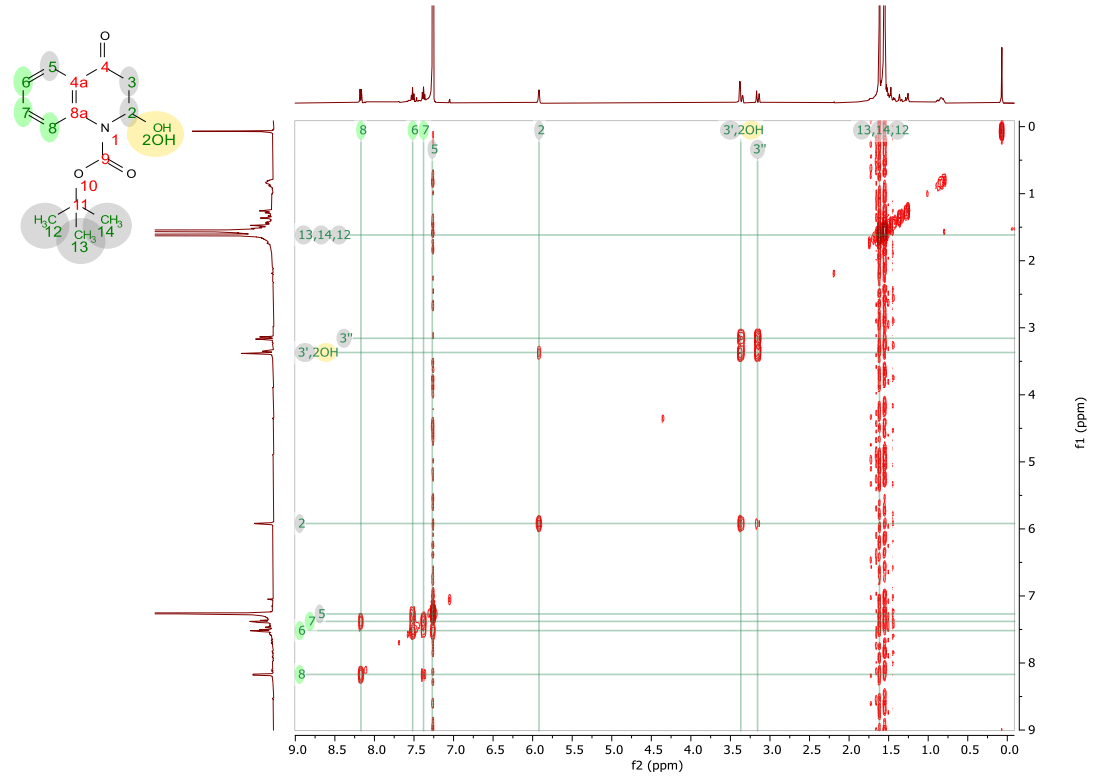
Spectrum 80 The ^{1}H NMR of the *anti*- and *syn*-**108**.



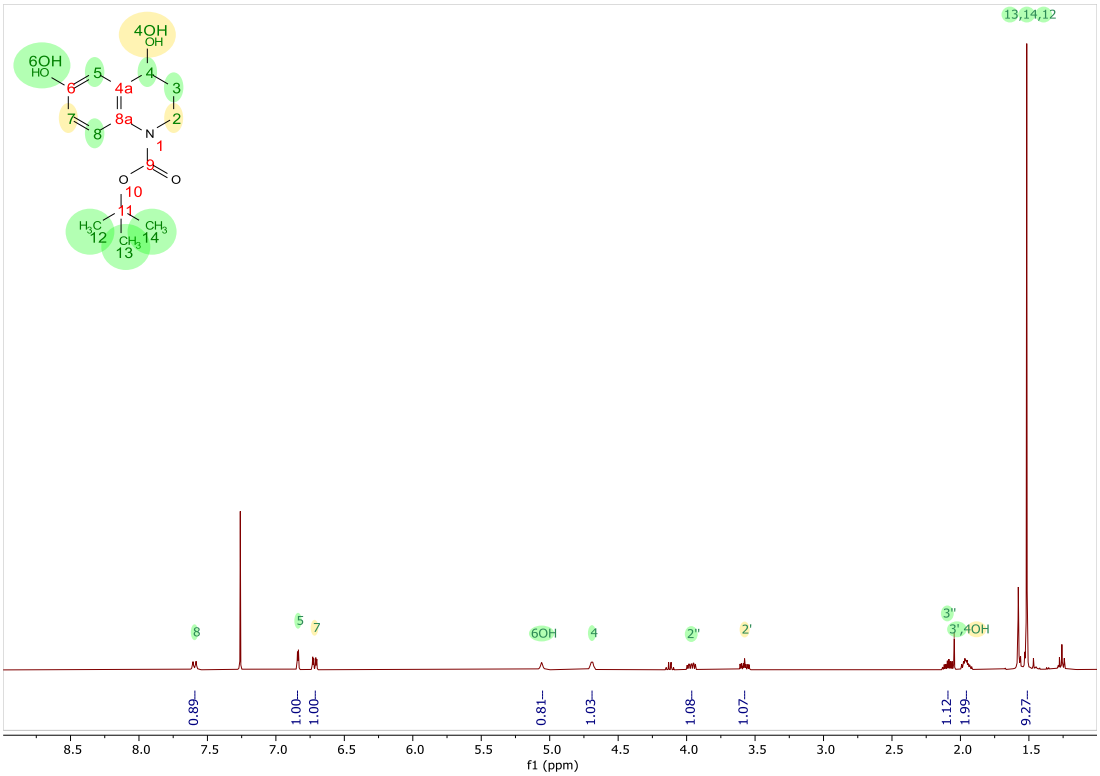
Spectrum 81 The COSY NMR of the *anti*- and *syn*-**108**.



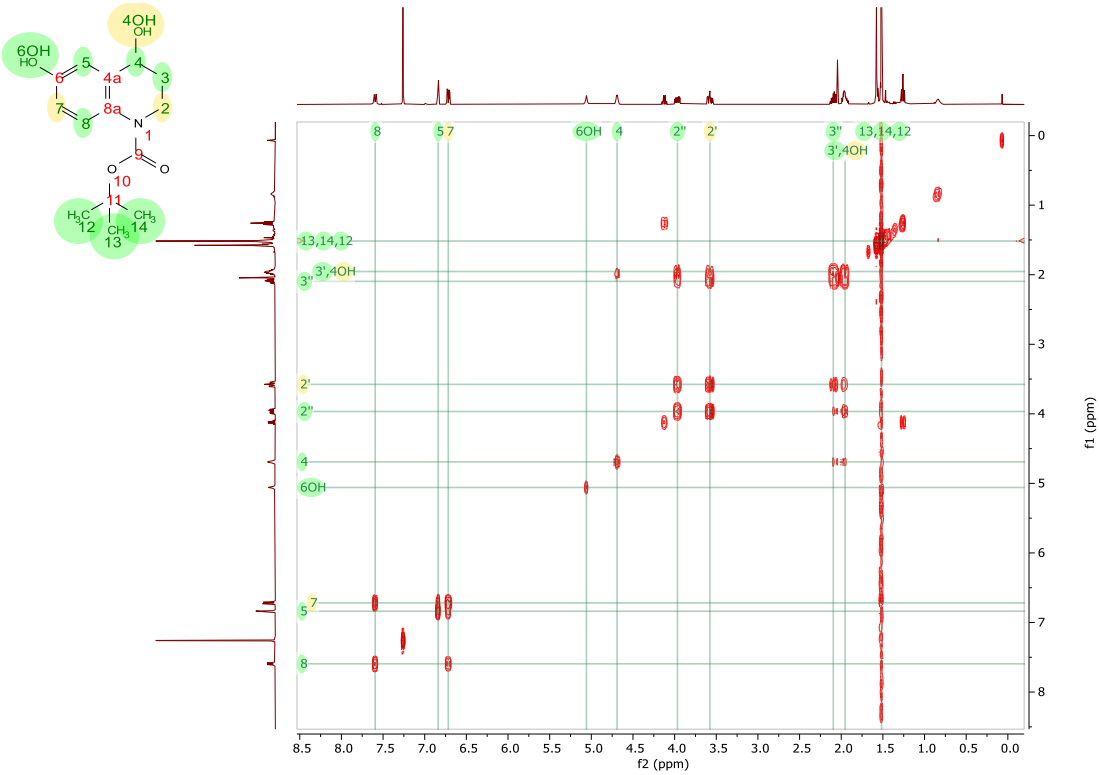
Spectrum 82 The ^{1}H NMR of **111**.



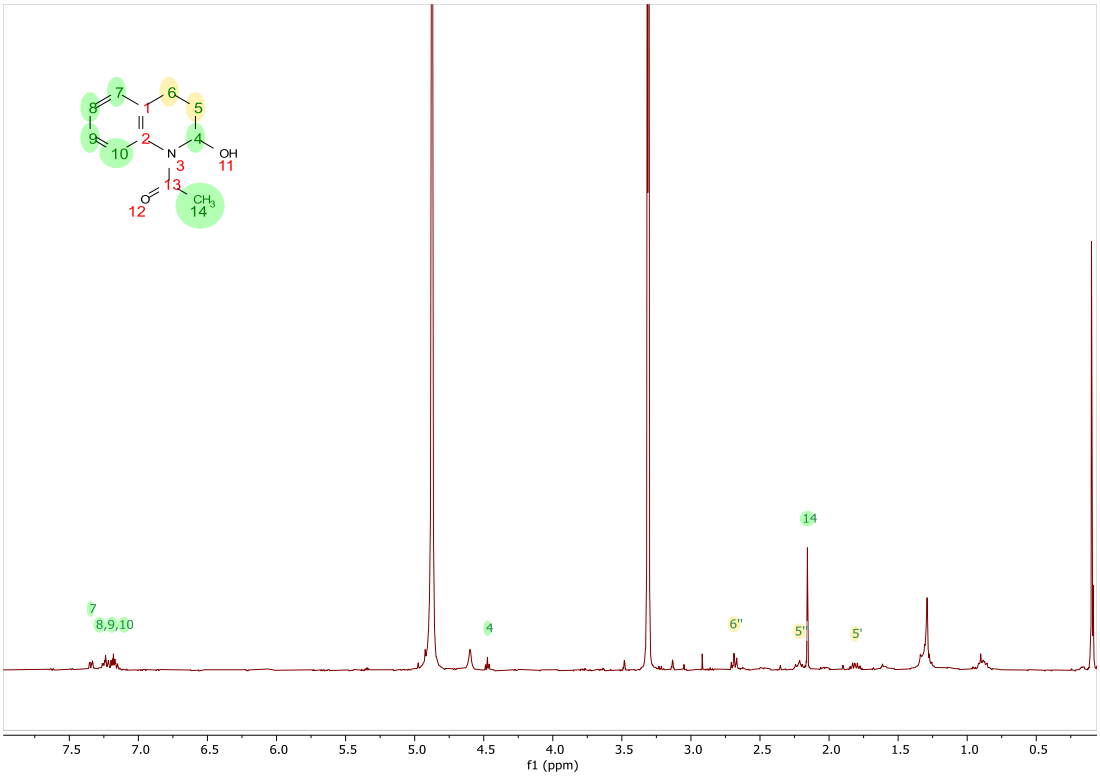
Spectrum 83 The COSY NMR of **111**.



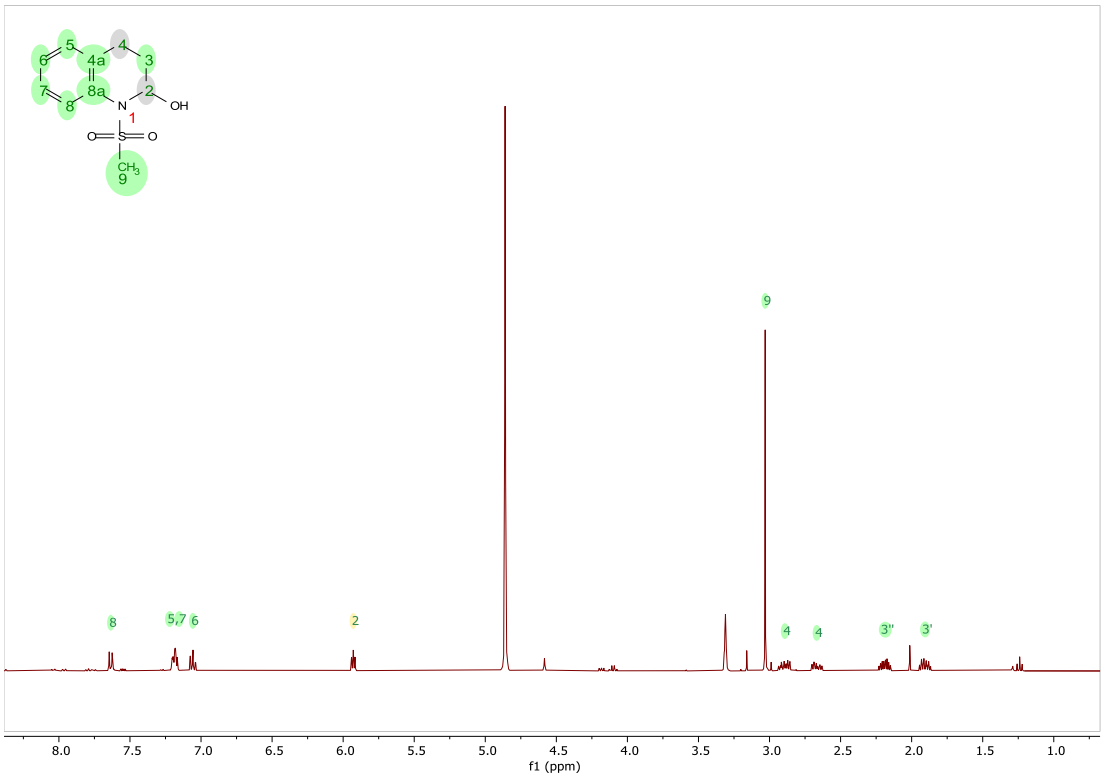
Spectrum 84 The ^{1}H NMR of **112**.



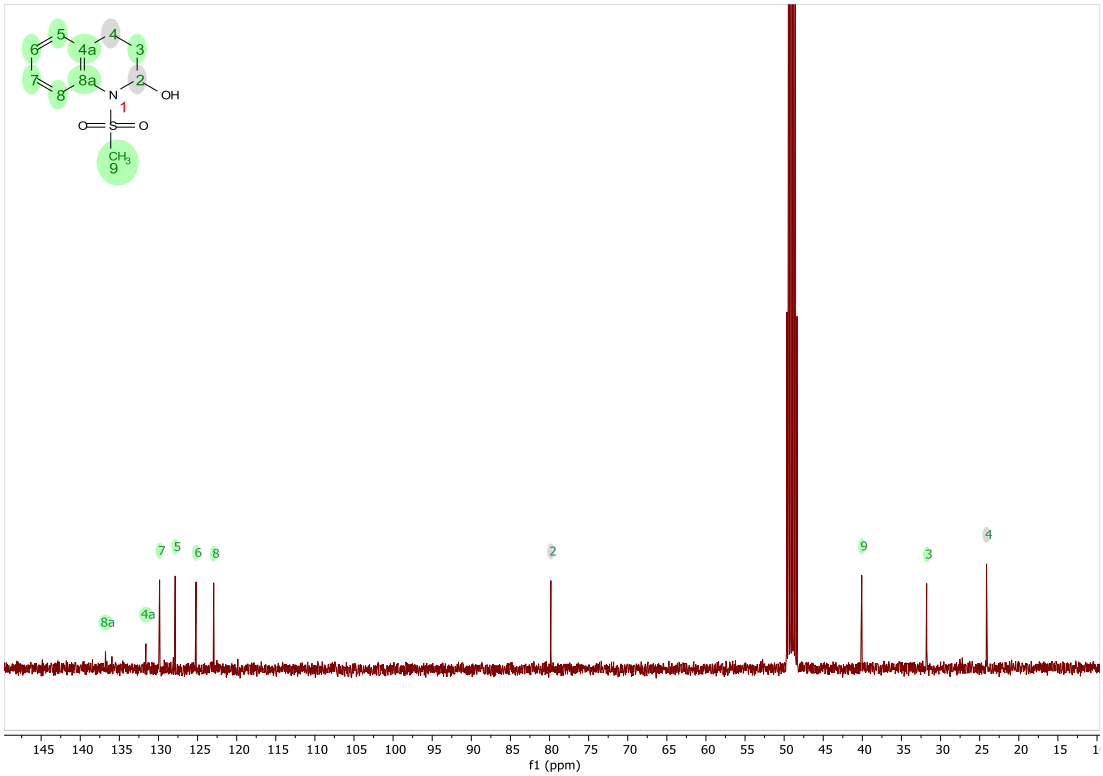
Spectrum 85 The COSY NMR of **112**.



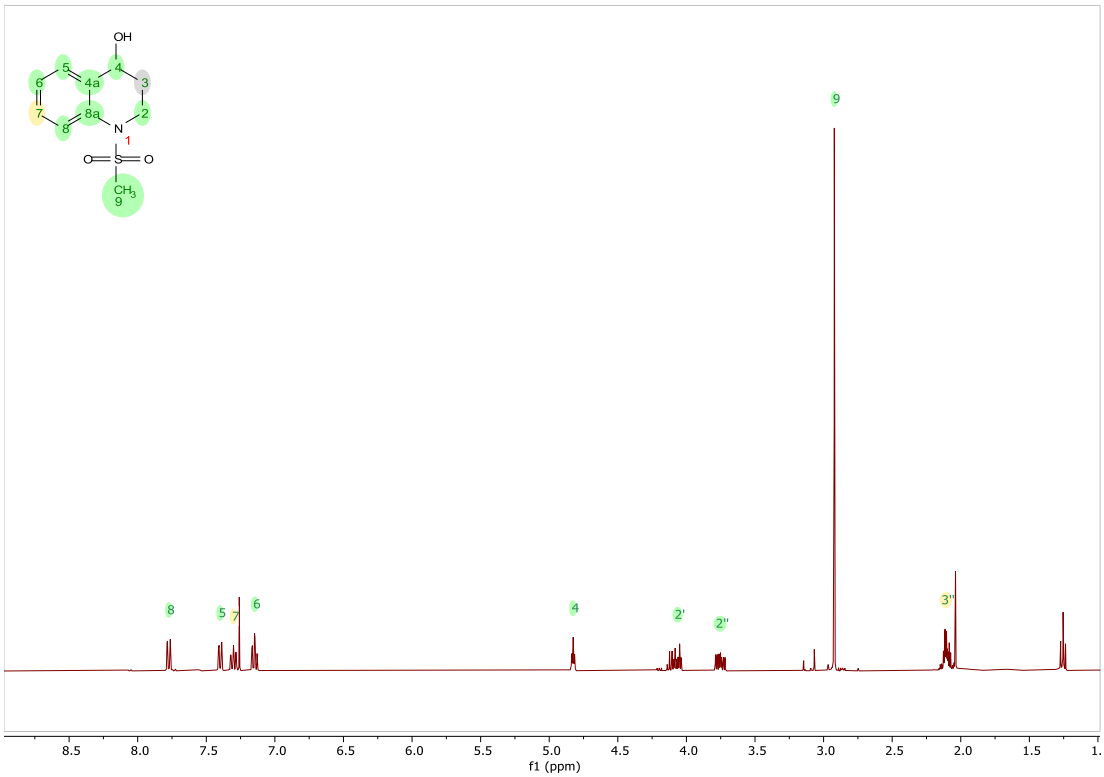
Spectrum 86 The ^{1}H NMR of **114**.



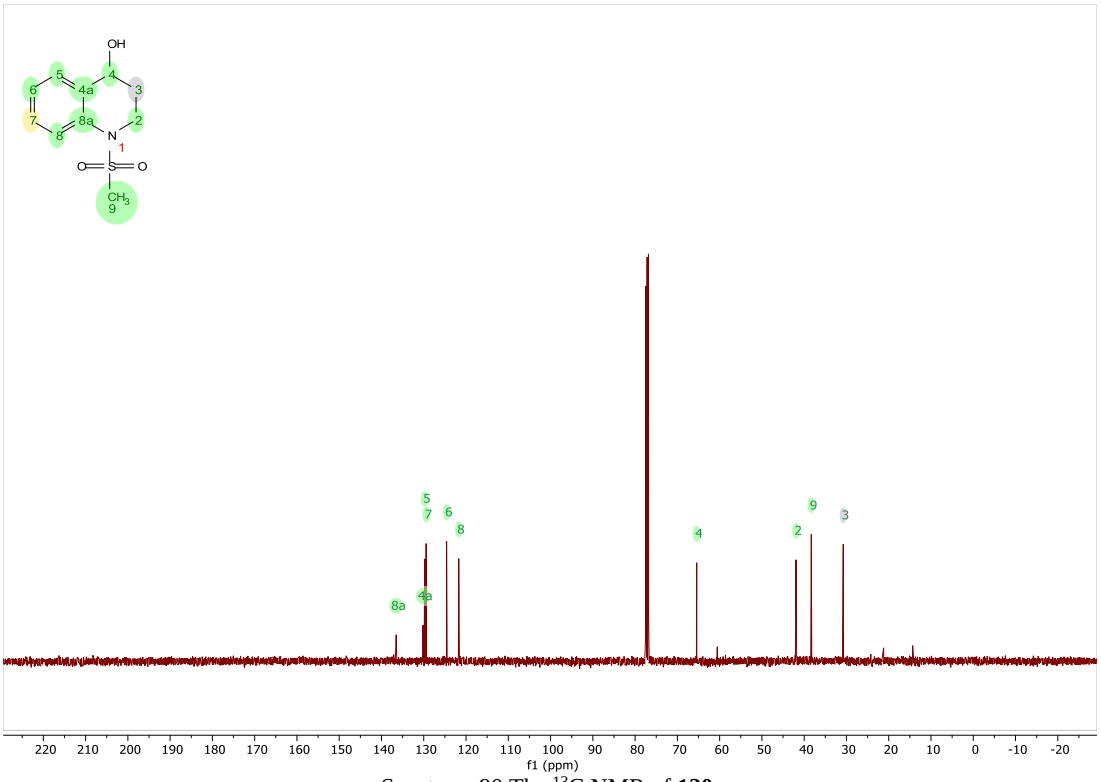
Spectrum 87 The ^{1}H NMR of **119**.



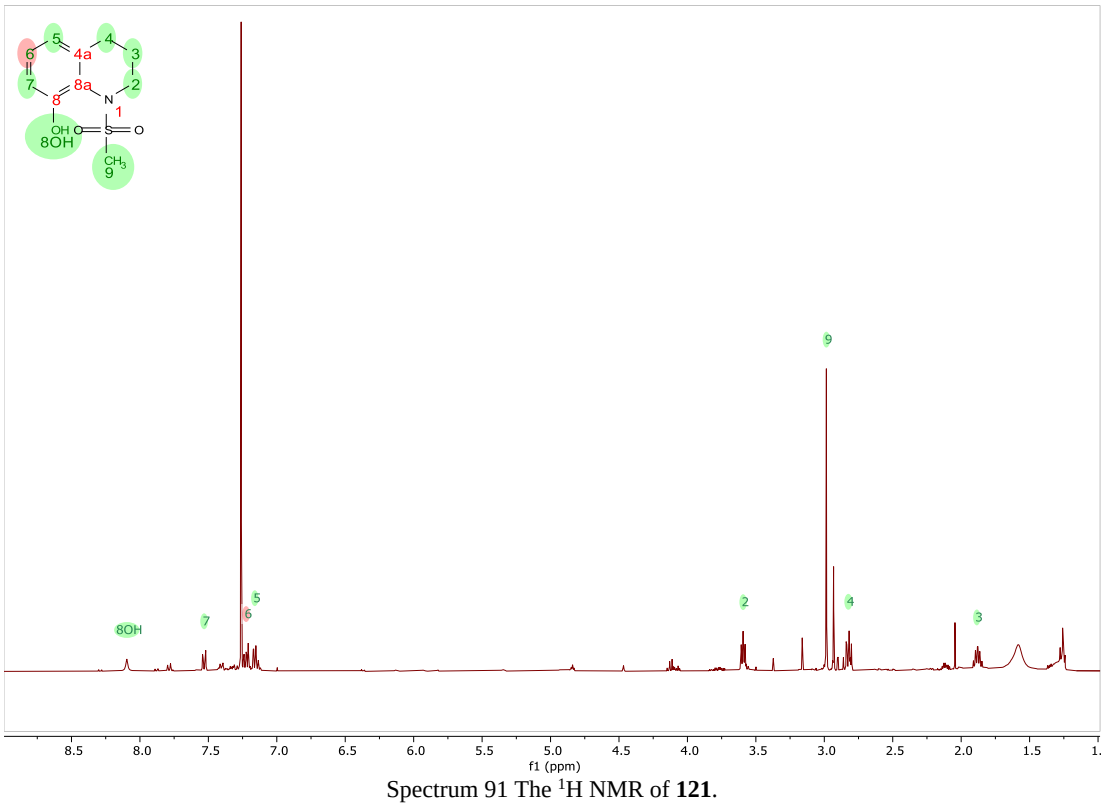
Spectrum 88 The ^{13}C NMR of **119**.



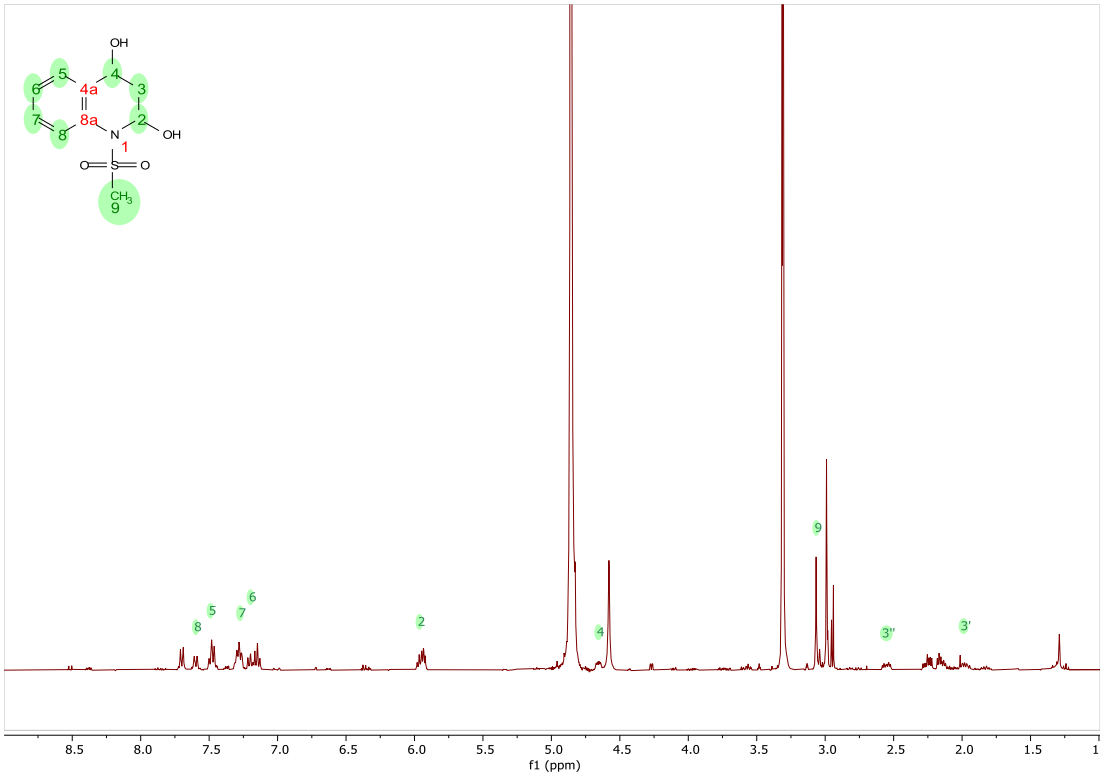
Spectrum 89 The ^{1}H NMR of **120**.



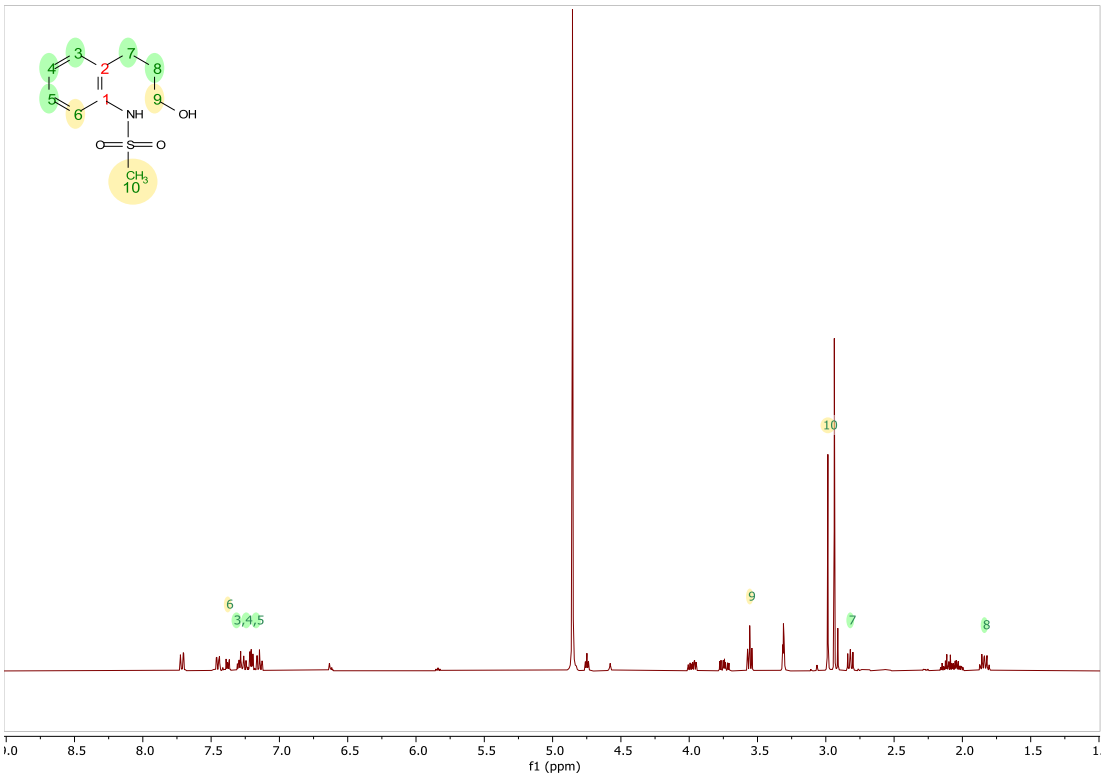
Spectrum 90 The ^{13}C NMR of **120**.



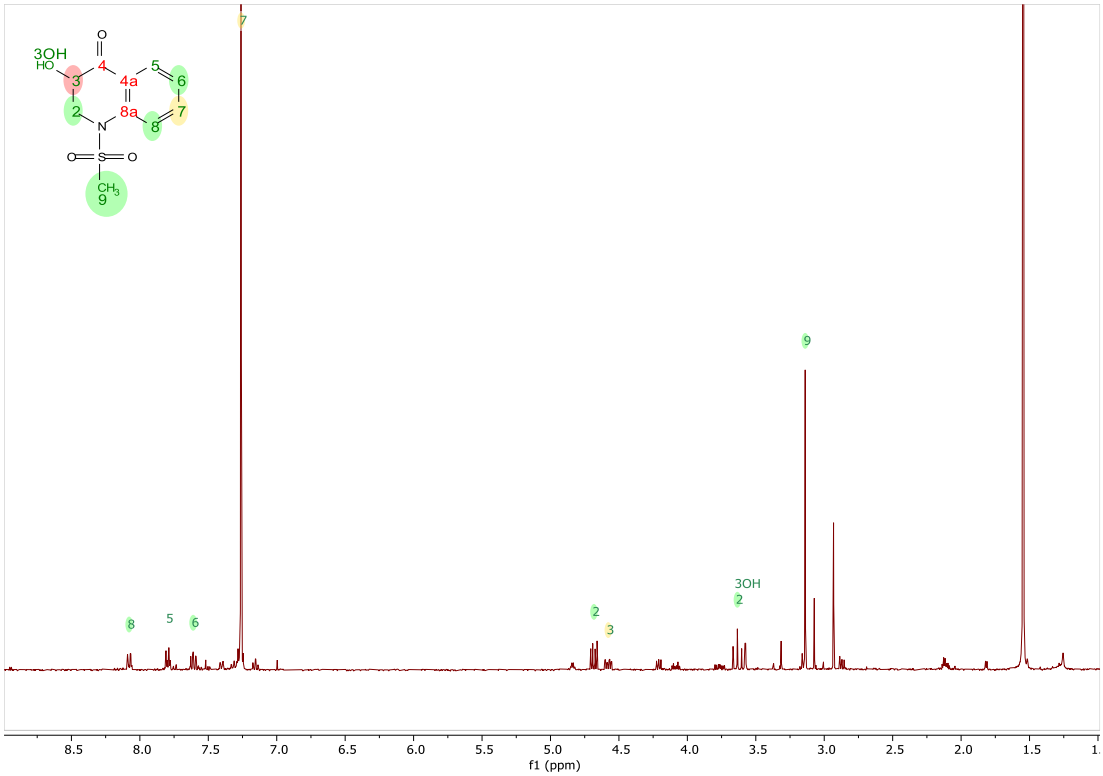
Spectrum 91 The ^{1}H NMR of **121**.



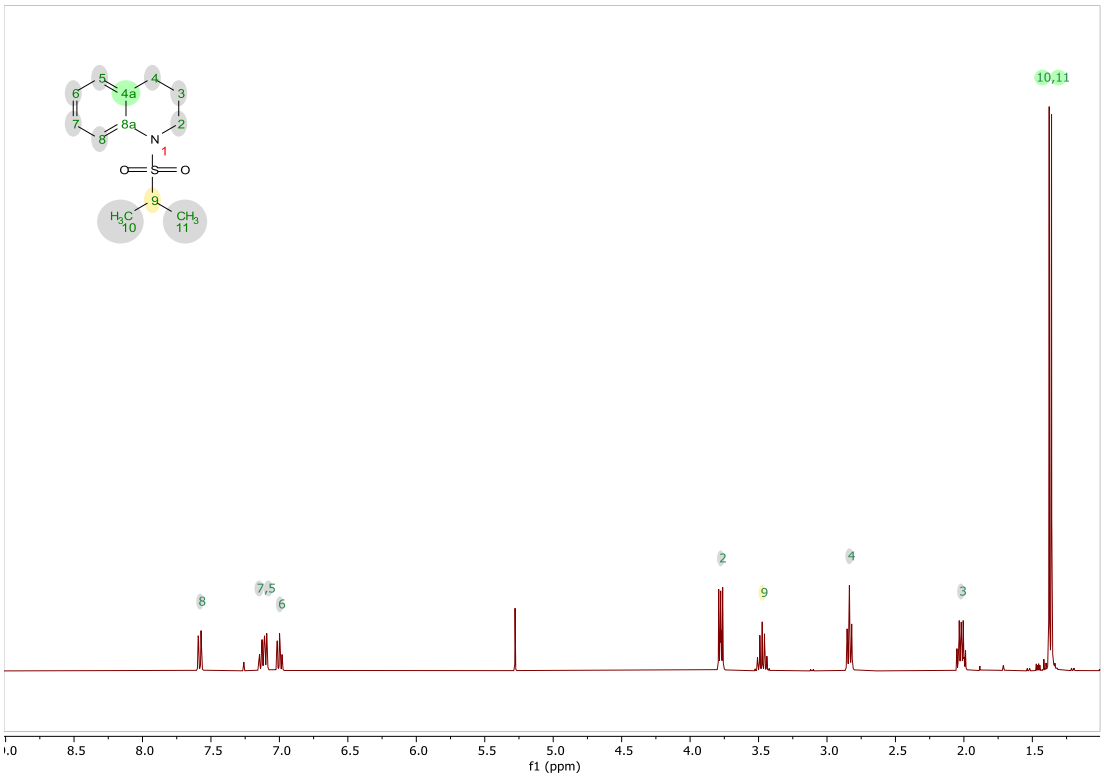
Spectrum 92 The ^{1}H NMR of **122**.



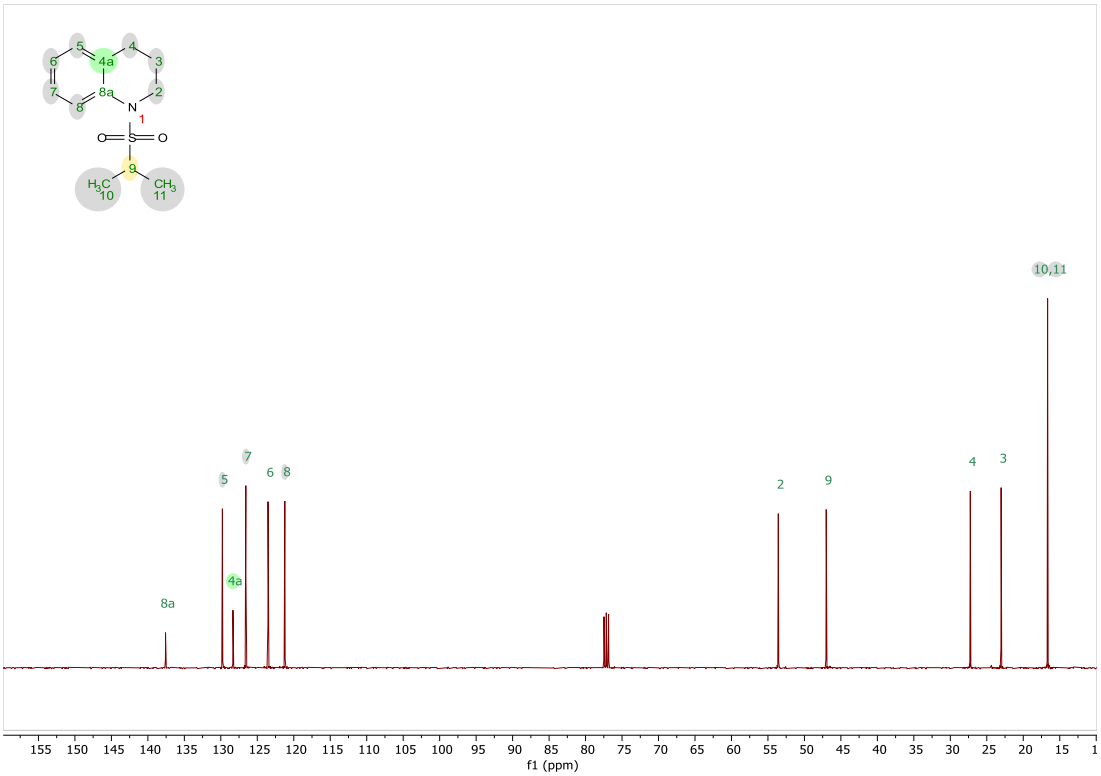
Spectrum 93 The ^{1}H NMR of **123**.



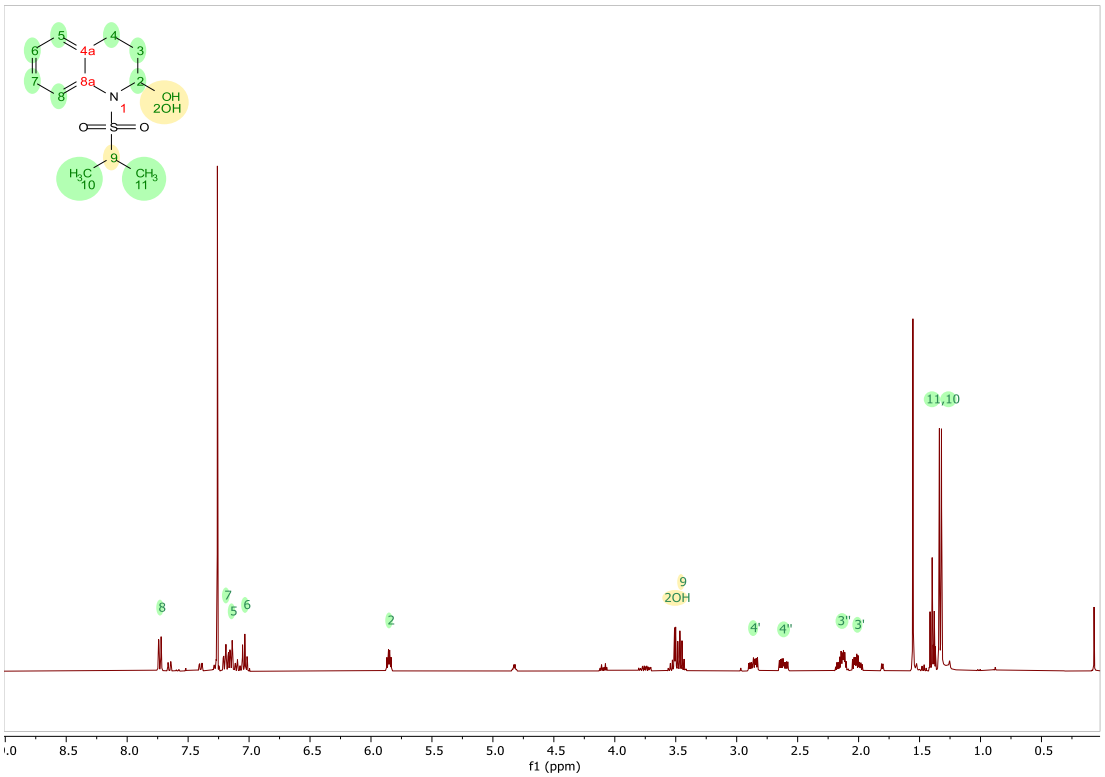
Spectrum 94 The ^{1}H NMR of **125**.



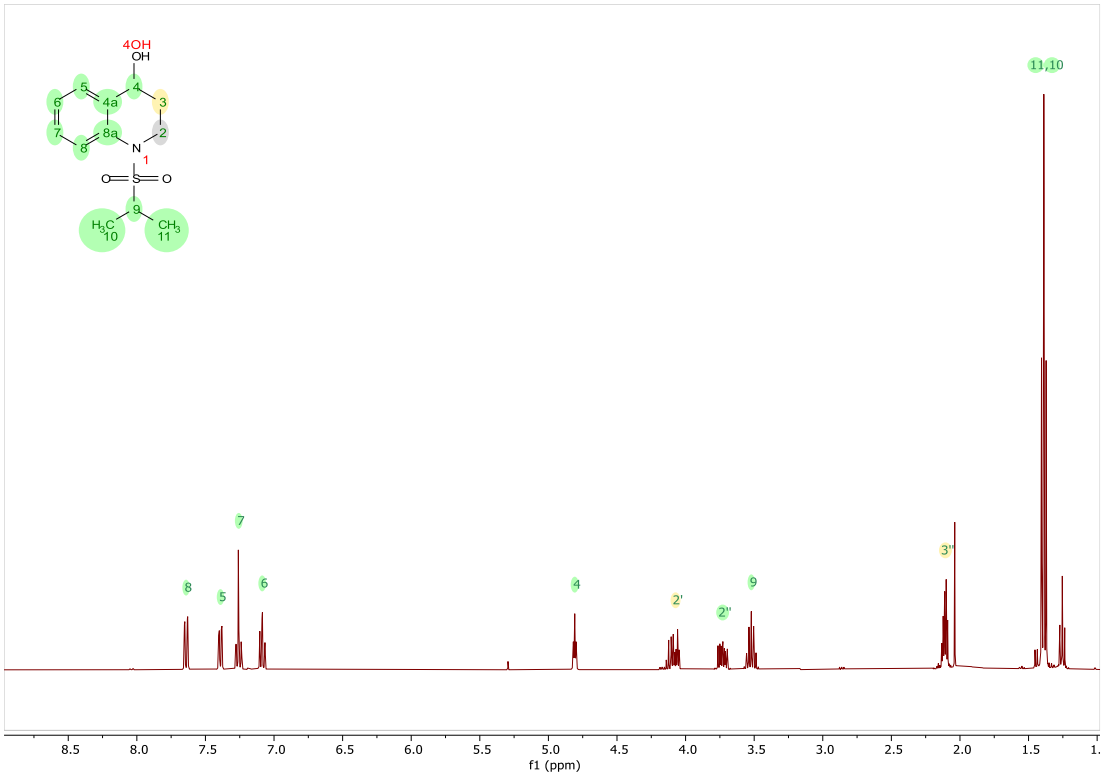
Spectrum 95 The ^{1}H NMR of **127**.



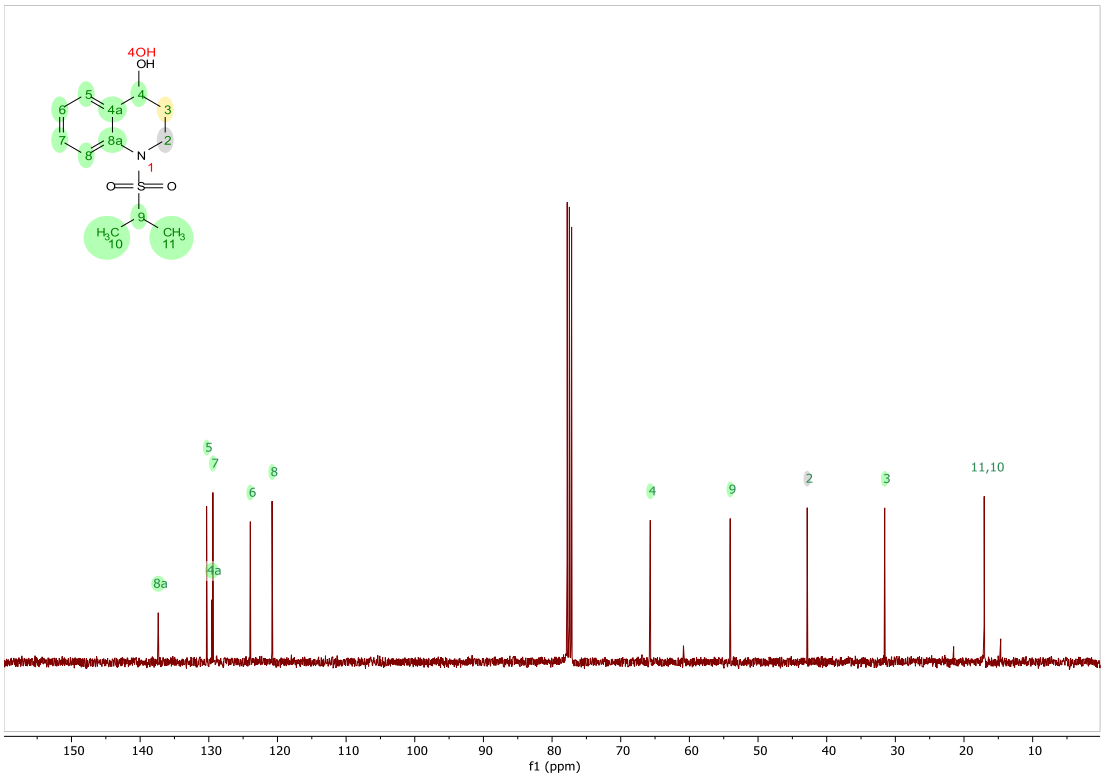
Spectrum 96 The ^{13}C NMR of **127**.



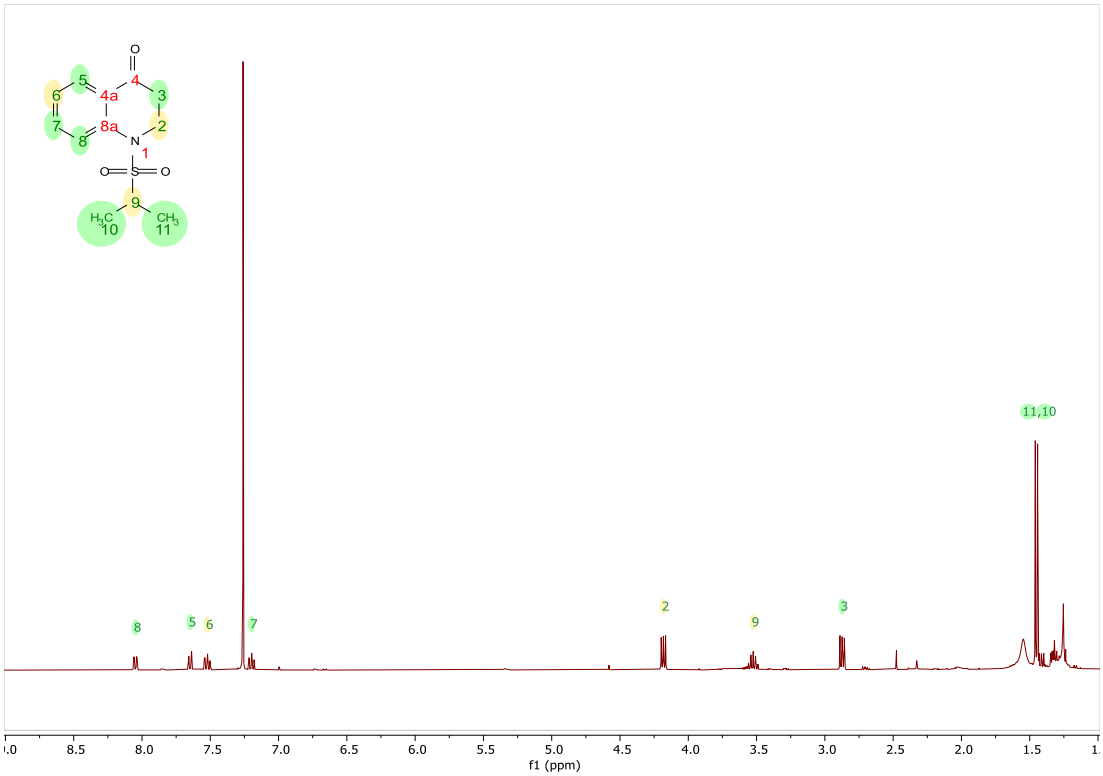
Spectrum 97 The ^{1}H NMR of **128**.



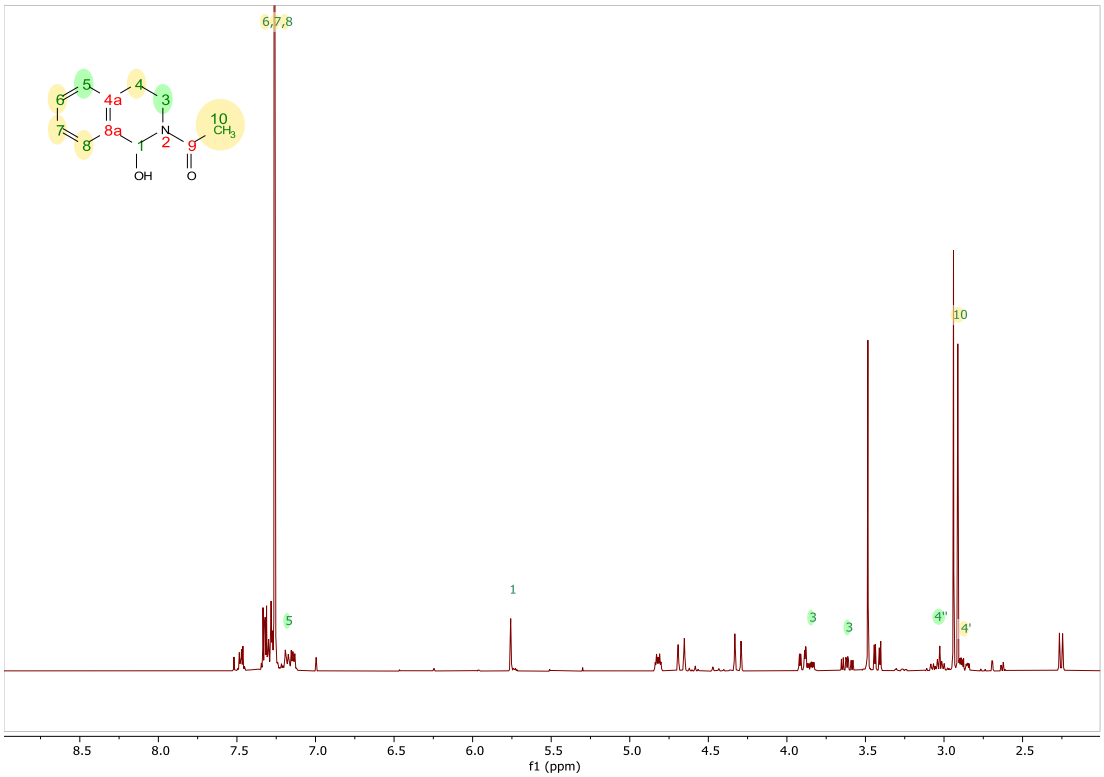
Spectrum 98 The ^{1}H NMR of **129**.



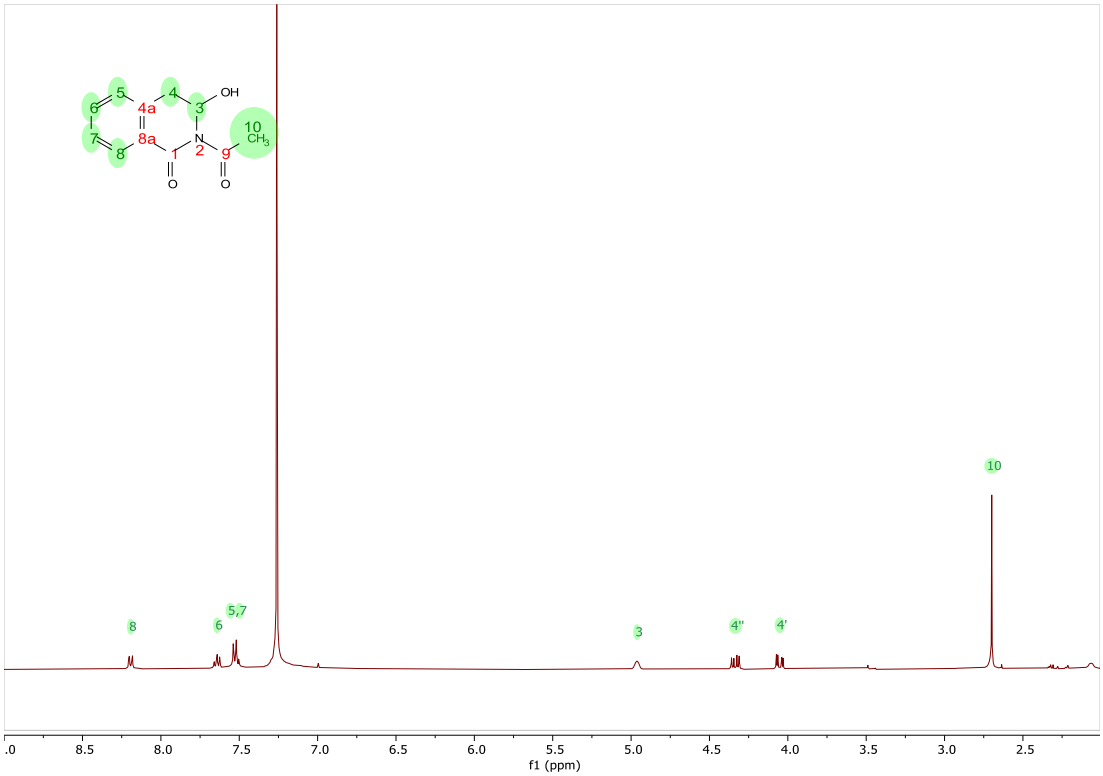
Spectrum 99 The ^{13}C NMR of **129**.



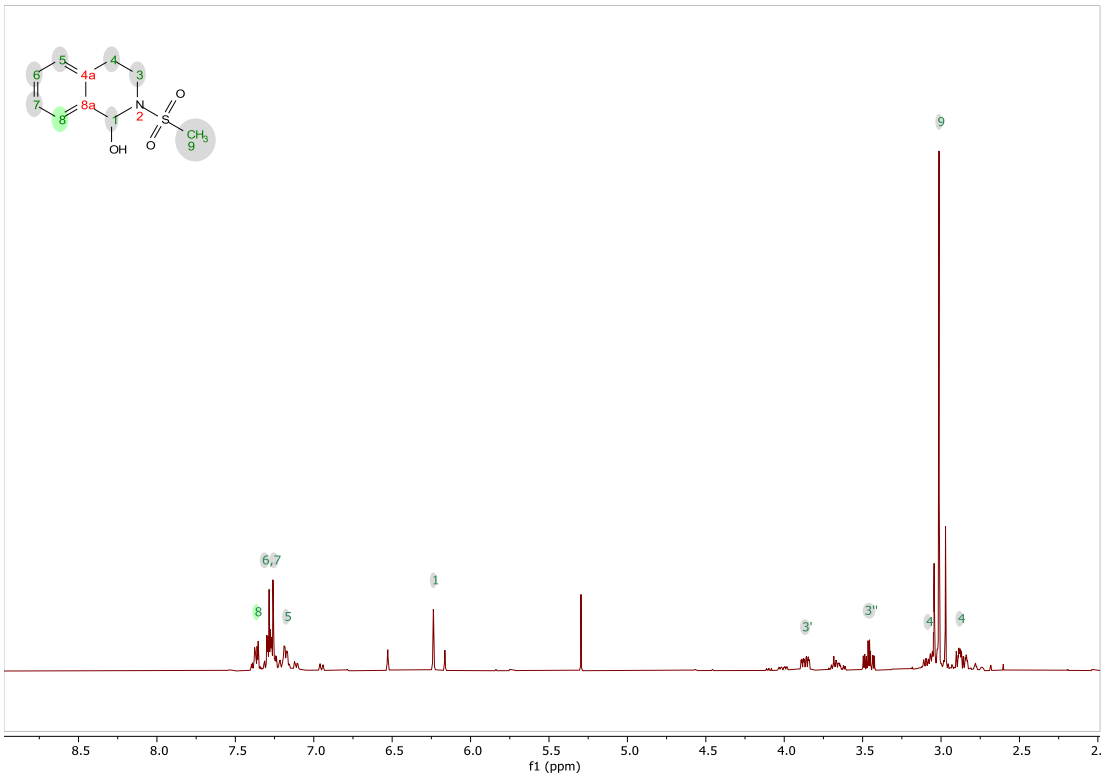
Spectrum 100 The ^{1}H NMR of **130**.



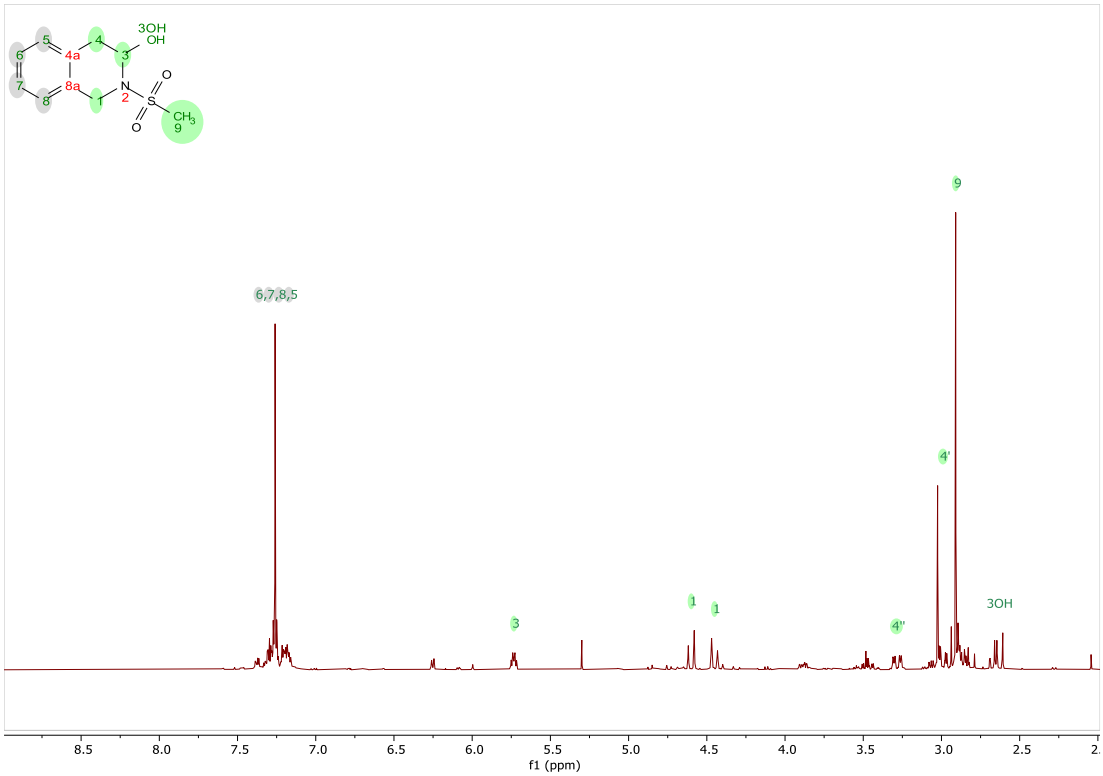
Spectrum 101 The ^{1}H NMR of **138**.



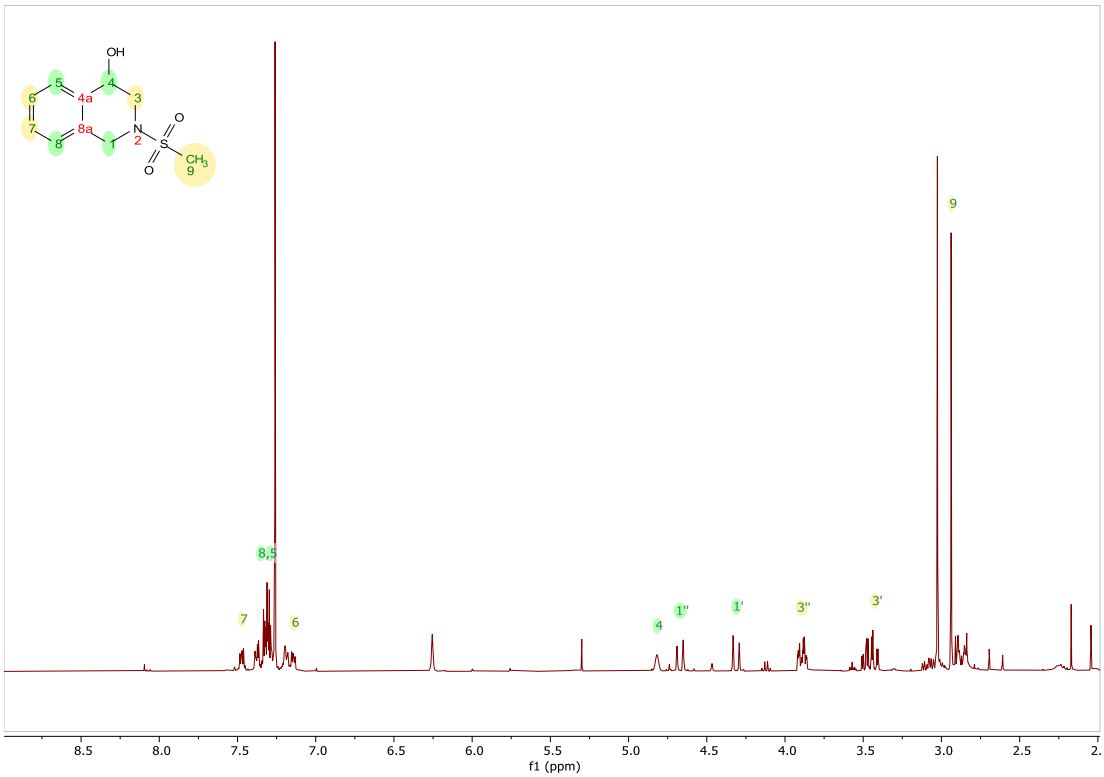
Spectrum 102 The ^{1}H NMR of **141**.



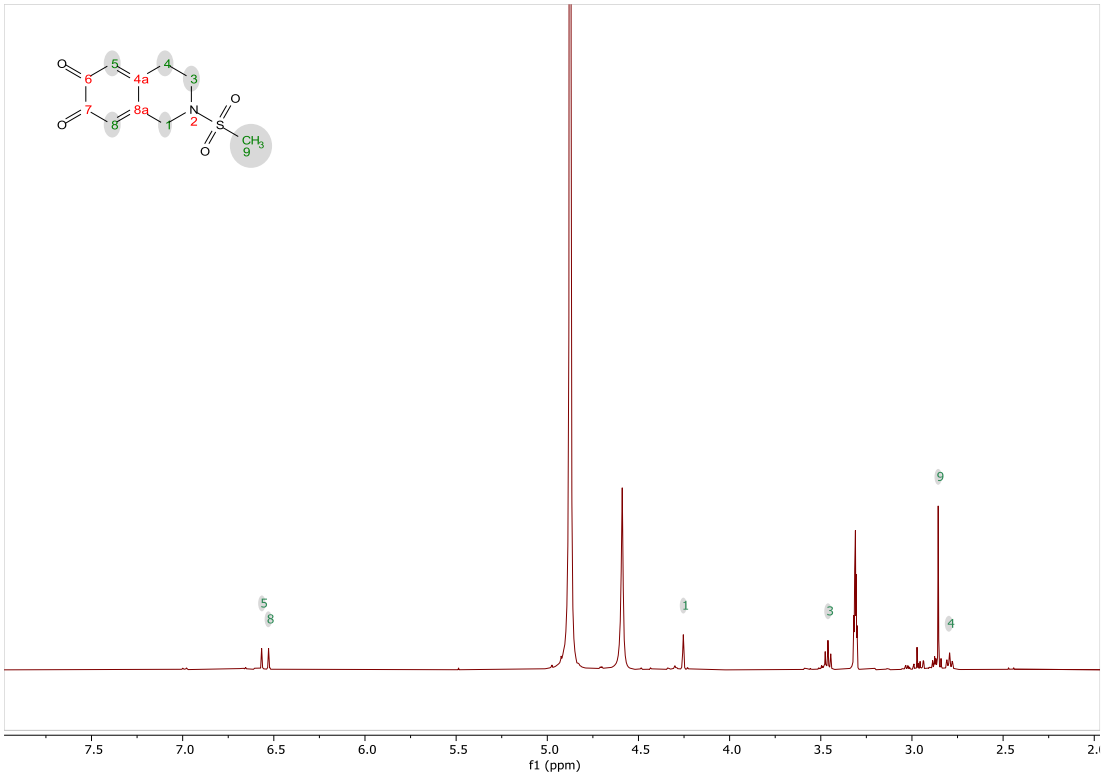
Spectrum 103 The ^{1}H NMR of **144**.



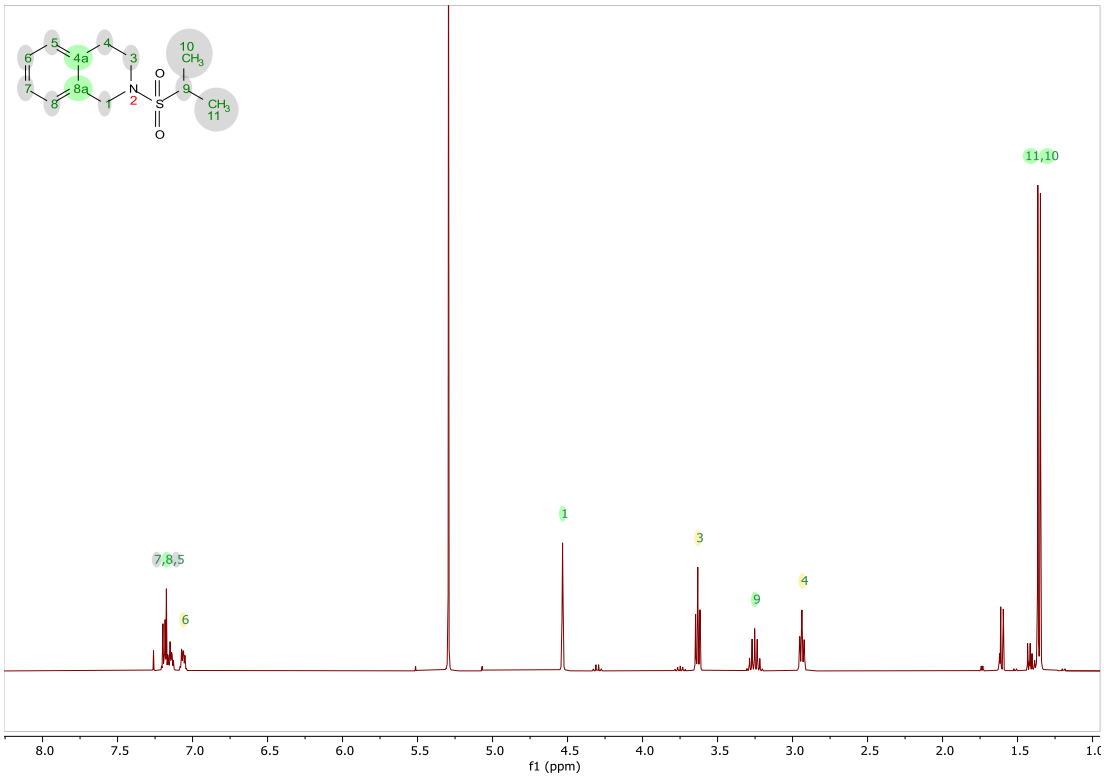
Spectrum 104 The ^{1}H NMR of **145**.



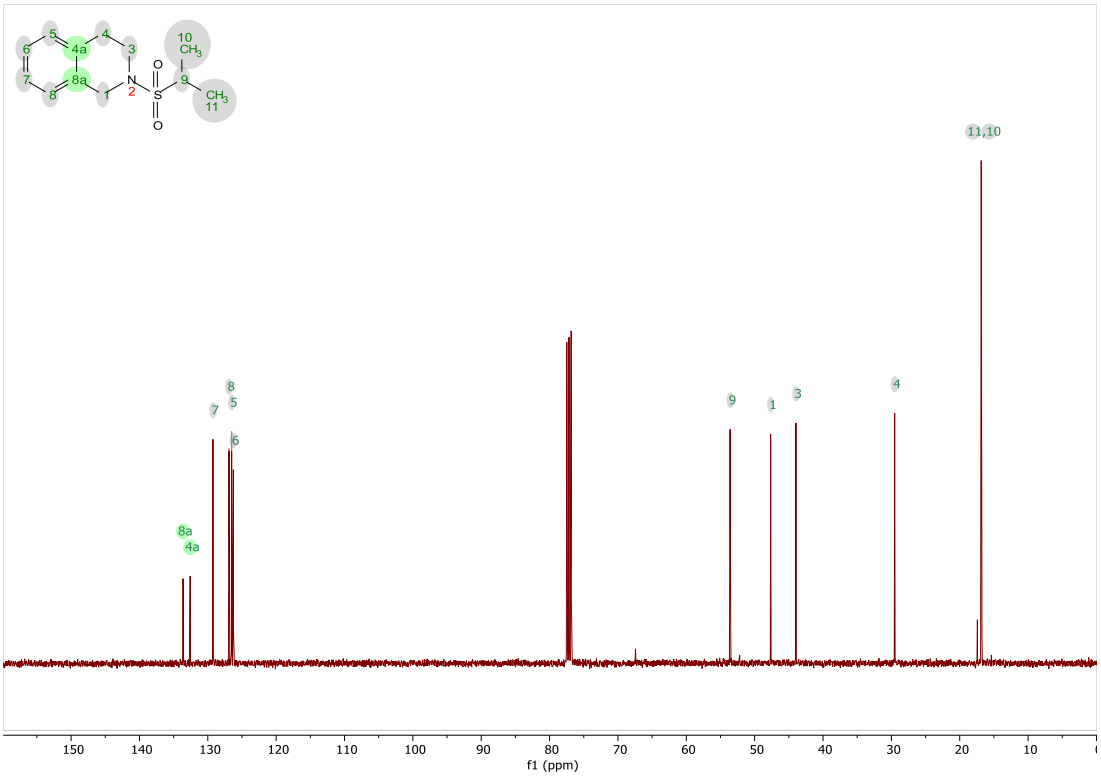
Spectrum 105 The ^{1}H NMR of **146**.



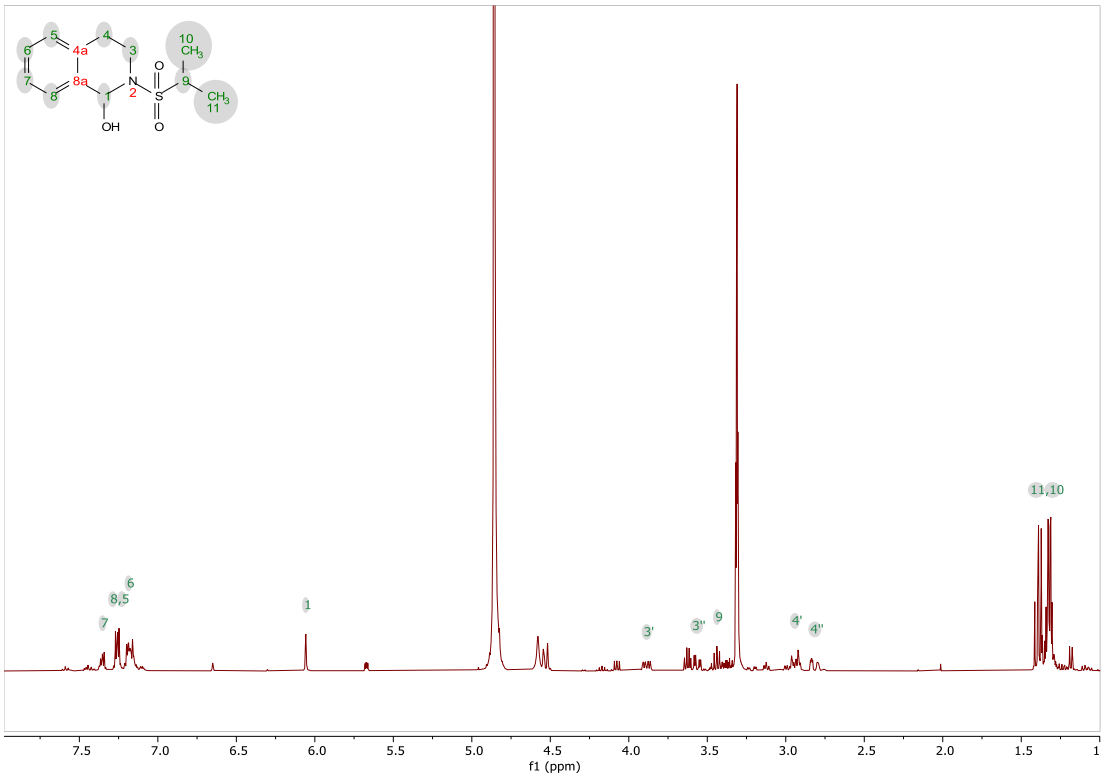
Spectrum 106 The ^{1}H NMR of **147**.



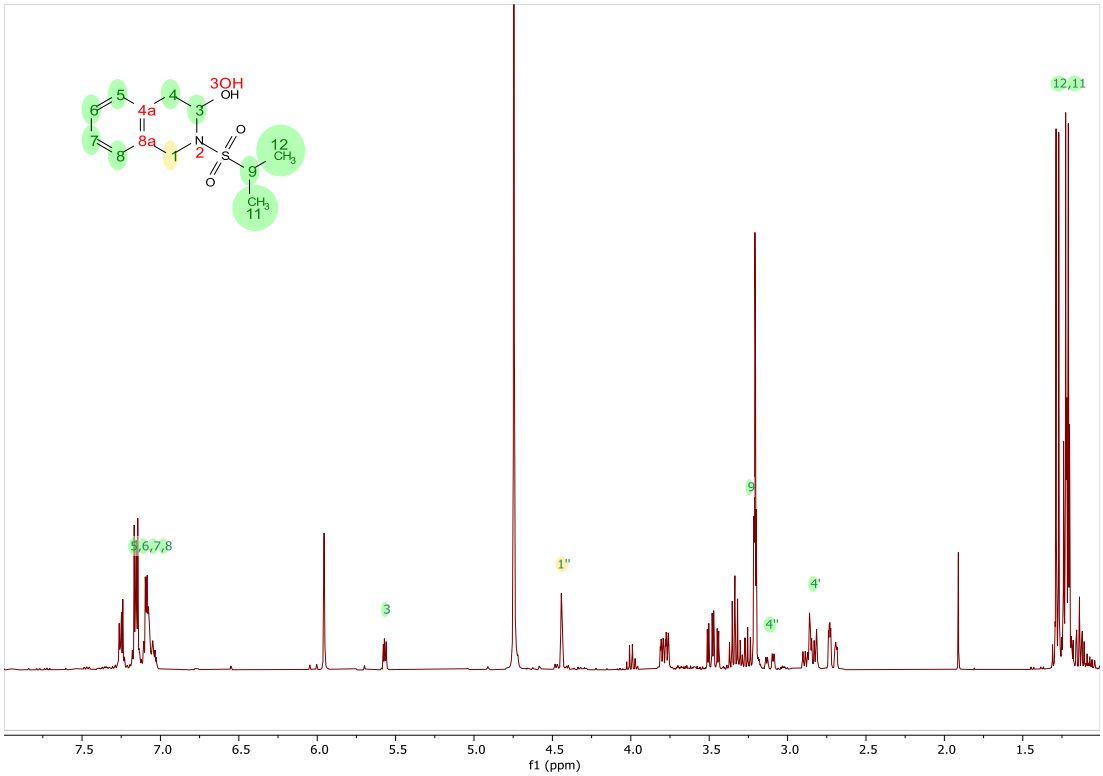
Spectrum 107 The ^{1}H NMR of **148**.



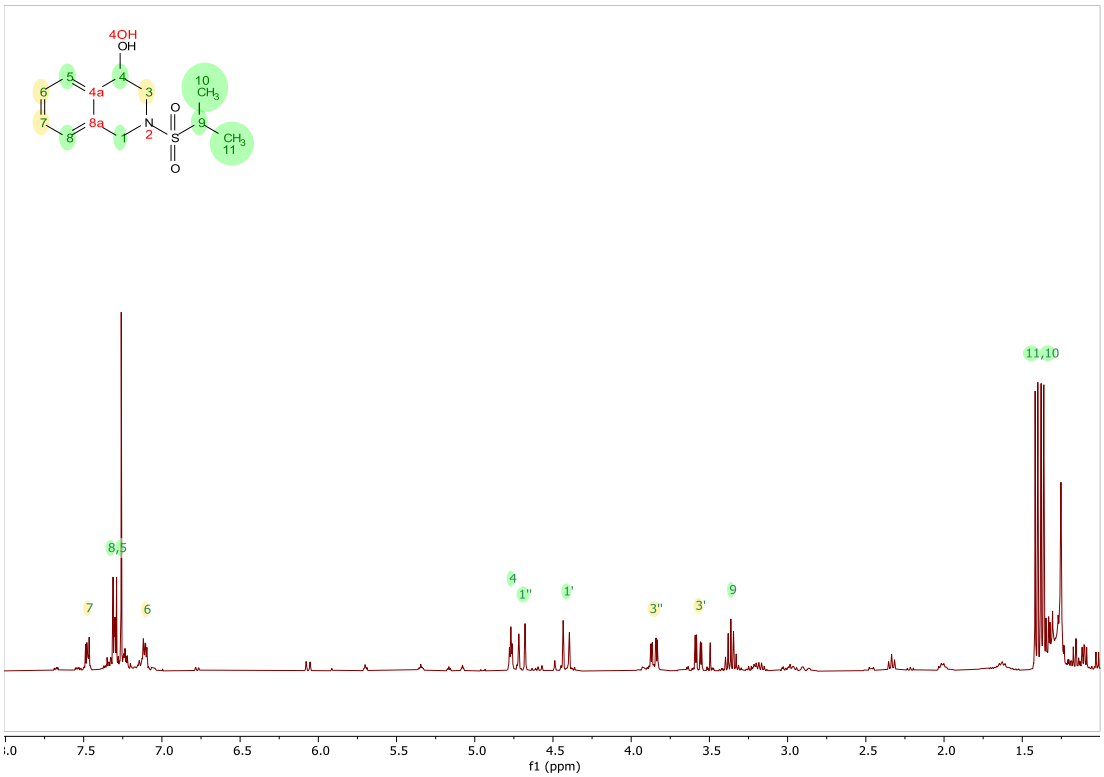
Spectrum 108 The ^{13}C NMR of **148**.



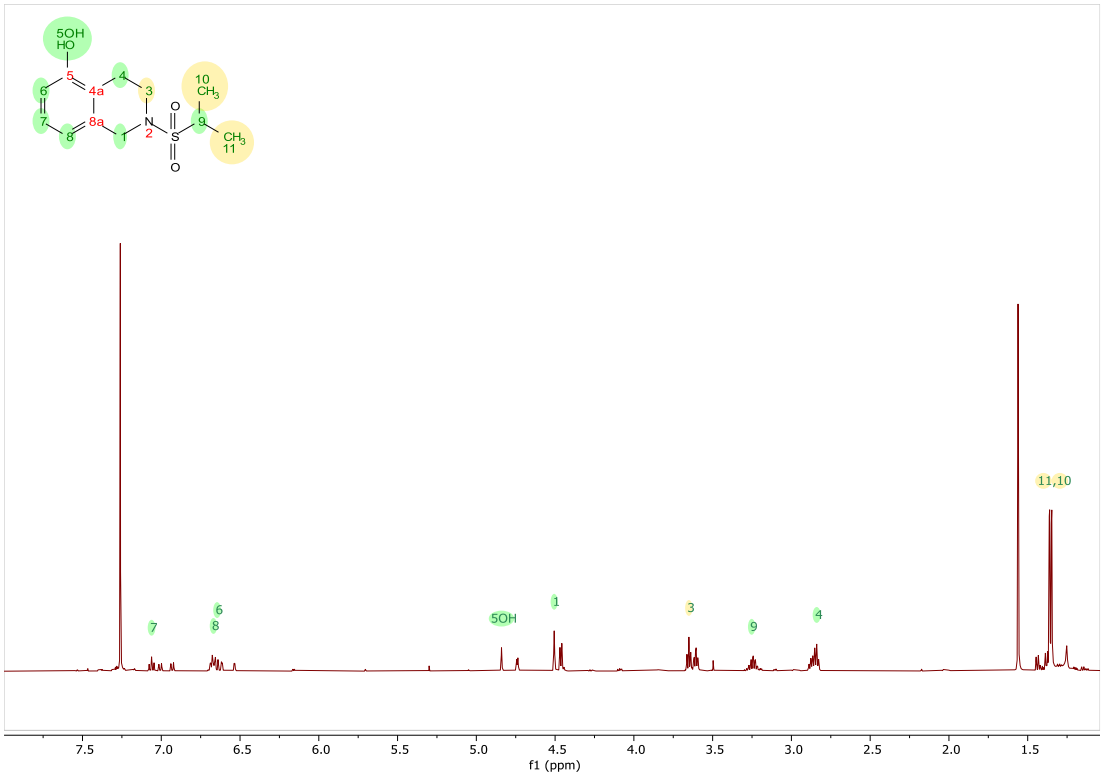
Spectrum 109 The ^{1}H NMR of **149**.



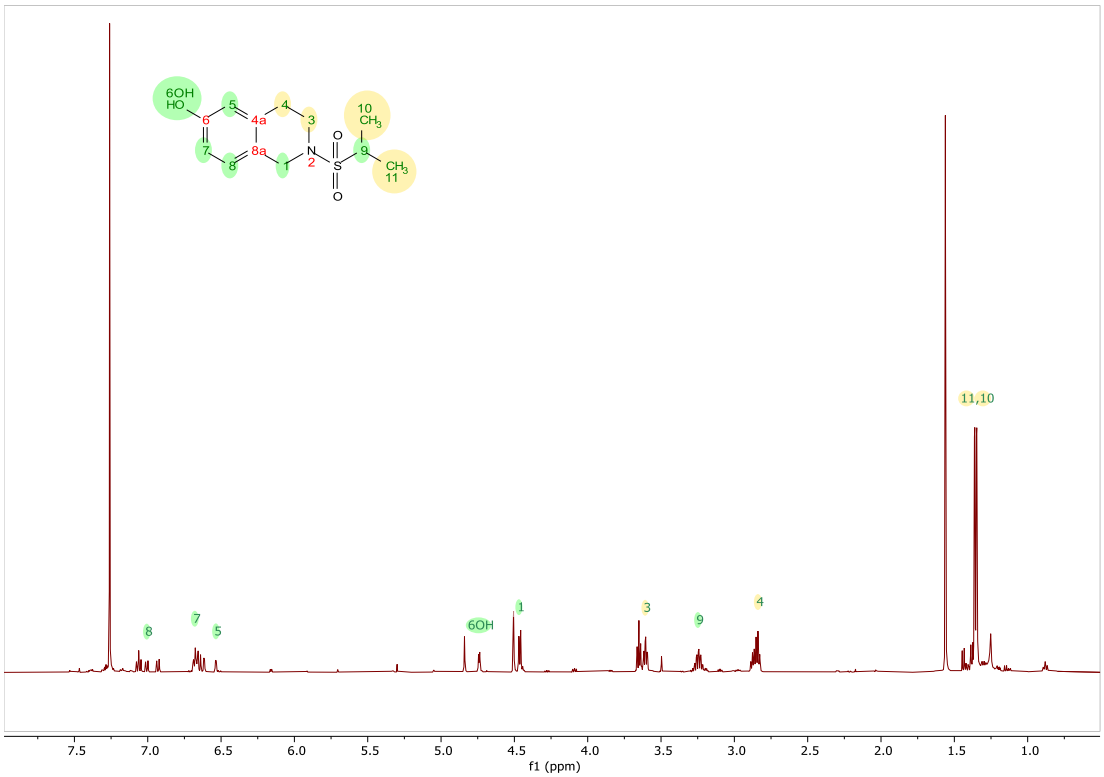
Spectrum 110 The ^{1}H NMR of **150**.



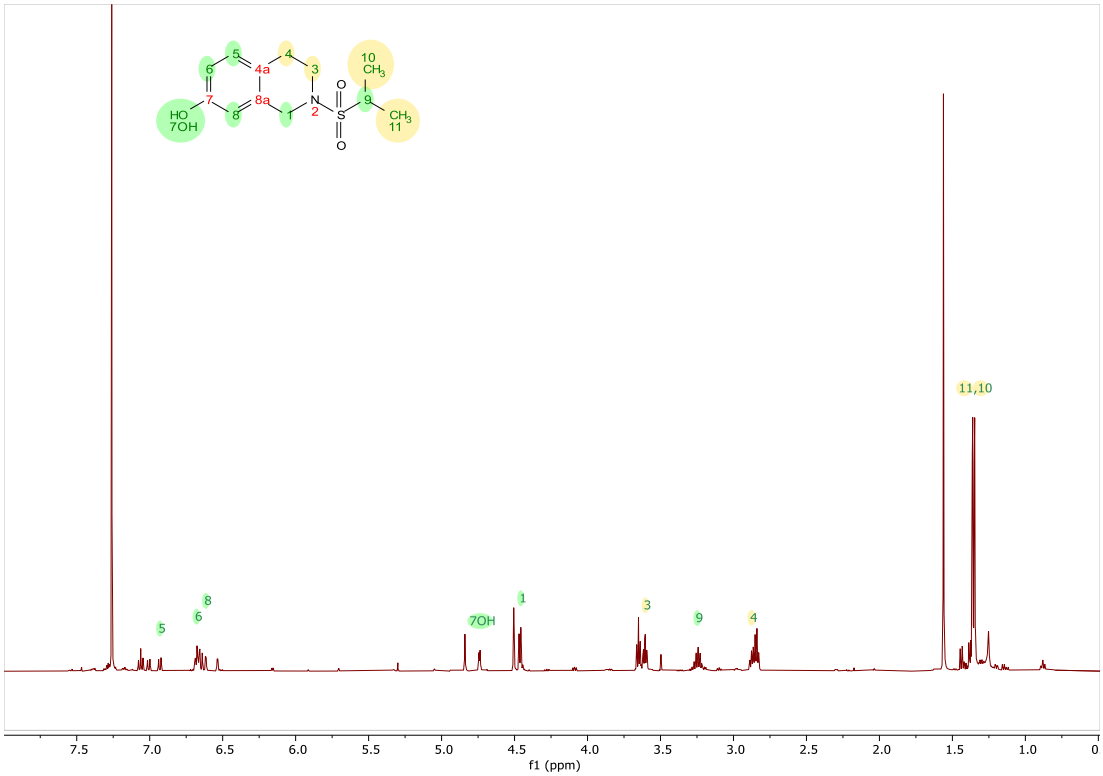
Spectrum 111 The ^{1}H NMR of **151**.



Spectrum 112 The ^{1}H NMR of **152**.

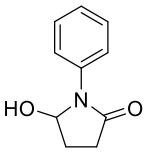


Spectrum 113 The ^{1}H NMR of **153**.



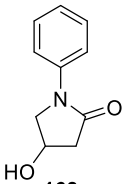
Spectrum 114 The ^{1}H NMR of **154**.

Appendix 4.5 The NMR and MS data of the products in Chapter 7.



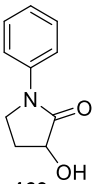
167

The title compound (**167**)[83] was obtained as a white solid (15 mg, 47% yield) using the described general method [from **166** (0.20 mmol) and the variant RP/H171L/I263G (0.10 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.50 (d, *J* = 7.9 Hz, 2H), 7.40 (t, *J* = 7.9 Hz, 2H), 7.24 (t, *J* = 8.6, 7.3 Hz, 1H), 5.67 (d, *J* = 5.6 Hz, 1H), 3.09 (d, *J* = 5.9 Hz, 1H), 2.83–2.71 (m, 1H), 2.53–2.38 (m, 2H), 2.09–2.00 (m, 1H) ppm. HRMS (ESI$^+$) calc. for $C_{10}H_{12}NO_2$ $[MH]^+$ 178.0863, found 178.0862.



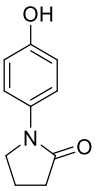
168

The title compound (**168**)[84] was obtained as a white solid (5.2 mg, 16% yield) using the described general method [from **166** (0.20 mmol) and the variant RP/A82M/I263G (0.10 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.59 (d, *J* = 7.9 Hz, 2H), 7.37 (d, *J* = 7.3 Hz, 2H), 7.16 (t, *J* = 7.5 Hz, 1H), 4.63 (dq, *J* = 6.8, 3.5 Hz, 1H), 4.11 (dd, *J* = 10.7, 5.5 Hz, 1H), 3.78 (dd, *J* = 10.7, 2.4 Hz, 1H), 2.92 (dd, *J* = 17.5, 6.5 Hz, 1H), 2.62 (d, *J* = 11.9 Hz, 1H), 2.29 (d, *J* = 4.5 Hz, 1H) ppm. HRMS (ESI$^+$) calc. for $C_{10}H_{12}NO_2$ $[MH]^+$ 178.0863, found 178.0864.



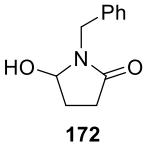
169

The title compound (**169**)[85] was obtained as a white solid (2.8 mg, 9% yield) using the described general method [from **166** (0.20 mmol) and the variant A330P (0.10 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.66–7.63 (m, 2H), 7.39 (dd, *J* = 8.6, 7.4 Hz, 2H), 7.19 (tt, *J* = 7.4, 1.2 Hz, 1H), 4.47 (t, *J* = 8.9 Hz, 1H), 3.86–3.74 (m, 2H), 2.97 (s, 1H), 2.61 (dddd, *J* = 12.6, 8.1, 6.3, 1.8 Hz, 1H), 2.11 (dd, *J* = 12.4, 9.5 Hz, 1H) ppm. HRMS (ESI$^+$) calc. for $C_{10}H_{12}NO_2$ $[MH]^+$ 178.0863, found 178.0864.



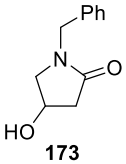
170

The title compound (**170**)[86] was obtained as a white solid (5.0 mg, 16% yield) using the described general method [from **166** (0.20 mmol) and the variant RP/H171L/I263G (0.10 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.36–7.33 (m, 2H), 6.82–6.75 (m, 2H), 3.81 (t, *J* = 7.0 Hz, 2H), 2.59 (t, *J* = 8.1 Hz, 2H), 2.17–2.12 (m, 2H) ppm. HRMS (ESI$^+$) calc. for $C_{10}H_{12}NO_2$ $[MH]^+$ 178.0863, found 178.0863.



172

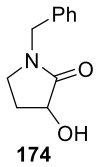
The title compound (**172**)[87] was obtained as a white solid (8.0 mg, 23% yield) using the described general method [from **171** (0.20 mmol) and the variant R19/F87A/A184I (0.10 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.37–7.27 (m, 5H), 5.09 (t, *J* = 6.1 Hz, 1H), 4.83 (d, *J* = 14.8 Hz, 1H), 4.24 (d, *J* = 14.8 Hz, 1H), 2.64 (ddd, *J* = 16.5, 9.6, 7.1 Hz, 1H), 2.39 (ddd, *J* = 16.6, 9.9, 3.7 Hz, 1H), 2.35–2.27 (m, 1H), 2.27–2.23 (m, 1H), 1.89 (ddt, *J* = 13.3, 9.8, 3.0 Hz, 1H) ppm. HRMS (ESI$^+$) calc. for $C_{11}H_{14}NO_2$ $[MH]^+$ 192.1020, found 192.1020.



173

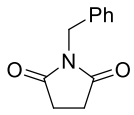
The title compound (**173**)[88] was obtained as a white solid (2.4 mg, 7% yield) using the described general method [from **171** (0.20 mmol) and the variant KU3/S72W/A330P (0.10 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.35–7.23 (m, 5H), 4.52 (d, *J* = 8.2 Hz, 1H), 4.49 (d, *J* = 7.5 Hz, 2H), 3.52 (dd, *J* = 10.9,

5.6 Hz, 1H), 3.19 (dd, *J* = 10.9, 2.2 Hz, 1H), 2.76 (dd, *J* = 17.4, 6.7 Hz, 1H), 2.45 (dd, *J* = 17.4, 2.6 Hz, 1H), 1.74 (d, *J* = 4.4 Hz, 1H) ppm. HRMS (ESI$^+$) calc. for $C_{11}H_{14}NO_2$ $[MH]^+$ 192.1020, found 192.1020.



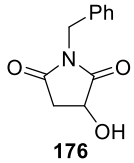
174

The title compound (**174**)[89] was obtained as a white solid (1.0 mg, 3% yield) using the described general method [from **171** (0.20 mmol) and the variant KU3/A330P (0.10 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.36–7.21 (m, 5H), 4.47 (dd, *J* = 25.8, 14.8 Hz, 2H), 4.37 (t, *J* = 8.8 Hz, 1H), 3.28–3.14 (m, 2H), 2.72 (d, *J* = 2.0 Hz, 1H), 2.46–2.39 (m, 1H), 1.96–1.88 (m, 1H) ppm. HRMS (ESI$^+$) calc. for $C_{11}H_{14}NO_2$ $[MH]^+$ 192.1020, found 192.1019.



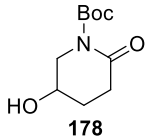
175

The title compound (**175**)[90] was obtained as a white solid (6.0 mg, 17% yield) using the described general method [from **171** (0.20 mmol) and the variant R19/F87A/A184I (0.10 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.41–7.37 (m, 2H), 7.30 (dddd, *J* = 10.7, 6.9, 4.6, 2.5 Hz, 3H), 4.66 (s, 2H), 2.71 (s, 4H) ppm. ^{13}C NMR (126 MHz, $CDCl_3$) δ 176.98, 135.93, 129.08, 128.80, 128.13, 42.58, 28.37 ppm. HRMS (ESI$^+$) calc. for $C_{11}H_{12}NO_2$ $[MH]^+$ 190.0863, found 190.0862.



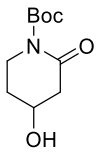
176

The title compound (**176**)[91] was obtained as a white solid (1.2 mg, 3% yield) using the described general method [from **171** (0.20 mmol) and the variant R19/F87A/A184I (0.10 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.38–7.27 (m, 5H), 4.83 (d, *J* = 14.9 Hz, 1H), 4.30 (d, *J* = 15.0 Hz, 1H), 4.24 (d, *J* = 6.5 Hz, 1H), 2.93 (dd, *J* = 17.7, 6.4 Hz, 1H), 2.37 (dd, *J* = 17.8, 2.5 Hz, 1H) ppm. HRMS (ESI$^+$) calc. for $C_{11}H_{12}NO_3$ $[MH]^+$ 206.0812, found 206.0811.



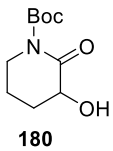
178

The title compound (**178**) was obtained as a white solid (1.2 mg, 3% yield) using the described general method [from **177** (0.20 mmol) and the variant R19/F87A/I263G (0.10 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (500 MHz, $CDCl_3$) δ 4.13 (dd, *J* = 11.5, 7.2 Hz, 1H), 3.78 (ddd, *J* = 13.4, 8.1, 5.4 Hz, 1H), 3.65–3.56 (m, 1H), 2.38–2.31 (m, 1H), 1.94–1.87 (m, 2H), 1.72–1.63 (m, 1H), 1.52 (s, 9H) ppm. HRMS (ESI$^+$) calc. for $C_{10}H_{18}NO_4$ $[MH]^+$ 216.1231, found 216.1232.



179

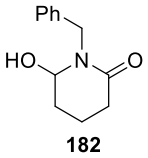
The title compound (**179**)[92] was obtained as a white solid (2.0 mg, 5% yield) using the described general method [from **177** (0.20 mmol) and the variant R19/F87A/I263G (0.10 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (500 MHz, $CDCl_3$) δ 4.14 (dd, *J* = 11.6, 7.2 Hz, 1H), 3.80 (ddd, *J* = 13.4, 8.1, 5.4 Hz, 1H), 3.61 (dd, *J* = 12.8, 6.2 Hz, 1H), 2.35 (t, *J* = 7.5 Hz, 2H), 1.93 (dd, *J* = 9.4, 4.1 Hz, 1H), 1.74–1.68 (m, 1H), 1.25 (s, 9H) ppm. HRMS (ESI$^+$) calc. for $C_{10}H_{18}NO_4$ $[MH]^+$ 216.1231, found 216.1230.



180

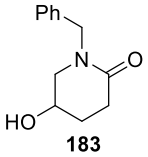
The title compound (**180**)[93] was obtained as a white solid (21.5 mg, 54% yield) using the described general method [from **177** (0.20 mmol) and the variant R19/F87A/I263G (0.10 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (500 MHz, $CDCl_3$) δ 4.63–4.55 (m, 1H), 3.51 (dt, *J* = 12.5, 6.0 Hz, 1H), 3.25 (dt, *J* = 14.4, 6.2 Hz, 1H), 2.54 (dd, *J*

= 9.7, 7.2 Hz, 2H), 2.28 (dd, *J* = 13.0, 7.2 Hz, 1H), 1.99–1.94 (m, 1H), 1.43 (s, 9H) ppm. HRMS (ESI$^+$) calc. for $C_{10}H_{18}NO_4$ [MH]$^+$ 216.1231, found 216.1233.



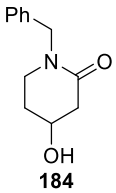
182

The title compound (**182**)[94] was obtained as a white solid (25.0 mg, 66% yield) using the described general method [from **181** (0.20 mmol) and the variant RT2/I401P (0.10 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.29 (hept, *J* = 7.5 Hz, 5H), 5.06 (d, *J* = 14.9 Hz, 1H), 4.93 (dt, *J* = 7.0, 3.6 Hz, 1H), 4.39 (d, *J* = 14.8 Hz, 1H), 2.60–2.49 (m, 2H), 2.42 (ddd, *J* = 17.6, 10.7, 6.4 Hz, 1H), 2.11–2.01 (m, 1H), 1.94–1.80 (m, 2H), 1.74 (ddd, *J* = 14.6, 7.6, 3.8 Hz, 1H) ppm. ^{13}C NMR (126 MHz, $CDCl_3$) δ 170.49, 137.80, 128.87, 128.33, 127.63, 79.29, 47.33, 32.59, 31.07, 16.04 ppm. HRMS (ESI$^+$) calc. for $C_{12}H_{16}NO_2$ [MH]$^+$ 206.1176, found 206.1172.



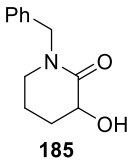
183

The title compound (**183**)[95] was obtained as a white solid (7.0 mg, 19% yield) using the described general method [from **181** (0.20 mmol) and the variant RP/H171L/I263G/L437LV (0.10 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.35–7.22 (m, 5H), 4.63–4.54 (m, 2H), 4.12 (qd, *J* = 5.9, 3.6 Hz, 1H), 3.37 (dd, *J* = 12.6, 4.2 Hz, 1H), 3.15 (dd, *J* = 12.6, 5.2 Hz, 1H), 2.79–2.61 (m, 1H), 2.46 (dt, *J* = 17.9, 6.4 Hz, 1H), 2.00–1.88 (m, 2H) ppm. ^{13}C NMR (126 MHz, $CDCl_3$) δ 169.45, 136.89, 128.81, 128.20, 127.64, 65.87, 64.21, 53.70, 50.20, 28.88, 28.26 ppm. HRMS (ESI$^+$) calc. for $C_{12}H_{16}NO_2$ [MH]$^+$ 206.1176, found 206.1173.



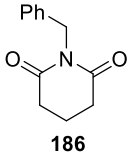
184

The title compound (**184**) was obtained as a white solid (2.4 mg, 6% yield) using the described general method [from **181** (0.20 mmol) and the variant RT2/A82M/A330P (0.10 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.37–7.22 (m, 5H), 4.61 (d, *J* = 4.0 Hz, 2H), 4.22 (d, *J* = 7.8 Hz, 1H), 3.41 (ddd, *J* = 12.5, 7.6, 5.1 Hz, 1H), 3.16 (ddd, *J* = 12.3, 6.9, 5.4 Hz, 1H), 2.77 (ddd, *J* = 17.5, 4.9, 1.4 Hz, 1H), 2.53–2.45 (m, 1H), 1.99 (qd, *J* = 7.9, 5.0, 3.6 Hz, 1H), 1.84 (dq, *J* = 13.3, 6.7 Hz, 1H), 1.70 (d, *J* = 3.5 Hz, 1H) ppm. HRMS (ESI$^+$) calc. for $C_{12}H_{16}NO_2$ [MH]$^+$ 206.1176, found 206.1175.



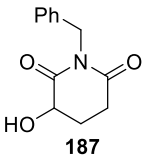
185

The title compound (**185**)[89] was obtained as a white solid (17.6 mg, 47% yield) using the described general method [from **181** (0.20 mmol) and the variant RT2/A184I/A330P (0.10 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.37–7.20 (m, 5H), 4.64 (d, *J* = 14.5 Hz, 1H), 4.52 (d, *J* = 14.6 Hz, 1H), 4.09 (dd, *J* = 11.1, 6.1 Hz, 1H), 3.22 (dd, *J* = 8.7, 4.8 Hz, 2H), 2.32–2.25 (m, 1H), 1.94–1.67 (m, 4H) ppm. ^{13}C NMR (126 MHz, $CDCl_3$) δ 172.67, 136.61, 128.86, 128.23, 127.79, 68.31, 50.52, 47.22, 28.44, 20.10 ppm. HRMS (ESI$^+$) calc. for $C_{12}H_{16}NO_2$ [MH]$^+$ 206.1176, found 206.1176.



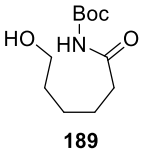
186

The title compound (**186**)[90] was obtained as a white solid (2.2 mg, 6% yield) using the described general method [from **181** (0.20 mmol) and the variant R19/F87A (0.10 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.36 (d, *J* = 7.4 Hz, 2H), 7.30–7.27 (m, 2H), 7.25–7.23 (m, 1H), 4.95 (s, 2H), 2.67 (t, *J* = 6.6 Hz, 4H), 1.94 (p, *J* = 6.5 Hz, 2H) ppm. HRMS (ESI$^+$) calc. for $C_{12}H_{14}NO_2$ [MH]$^+$ 204.1020, found 204.1021.



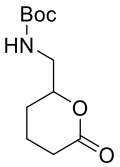
187

The title compound (**187**)[96] was obtained as a white solid (4.1 mg, 11% yield) using the described general method [from **181** (0.20 mmol) and the variant R19/F87A (0.10 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.38–7.26 (m, 5H), 4.95 (s, 2H), 4.23 (ddd, *J* = 12.6, 5.6, 1.4 Hz, 1H), 3.50 (d, *J* = 1.5 Hz, 1H), 2.92 (ddd, *J* = 18.1, 4.8, 2.6 Hz, 1H), 2.66 (ddd, *J* = 18.0, 13.8, 5.5 Hz, 1H), 2.34 (dtd, *J* = 13.3, 5.5, 2.5 Hz, 1H), 1.91 (qd, *J* = 13.0, 4.8 Hz, 1H) ppm. ^{13}C NMR (126 MHz, $CDCl_3$) δ 175.32, 171.17, 136.64, 128.98, 128.68, 127.91, 68.57, 43.79, 31.05, 25.41 ppm. HRMS (ESI^+) calc. for $C_{12}H_{14}NO_3$ $[MH]^+$ 220.0969, found 220.0970.



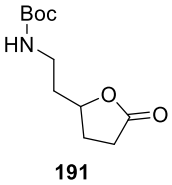
189

The title compound (**189**) was obtained as a white solid (9.7 mg, 23% yield) using the described general method [from **188** (0.20 mmol) and the variant R19/F87A (0.10 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (500 MHz, $CDCl_3$) δ 3.66 (t, *J* = 6.5 Hz, 2H), 2.75 (t, *J* = 7.4 Hz, 2H), 1.72–1.67 (m, 2H), 1.62–1.59 (m, 2H), 1.49 (s, 9H), 1.47–1.40 (m, 2H) ppm. HRMS (ESI^+) calc. for $C_{11}H_{22}NO_4$ $[MH]^+$ 232.1554, found 232.1554.



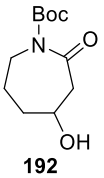
190

The title compound (**190**)[97] was obtained as a white solid (1.1 mg, 3% yield) using the described general method [from **188** (0.20 mmol) and the variant K19/F87V (0.10 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (500 MHz, $CDCl_3$) δ 5.02 (s, 1H), 4.44–4.33 (m, 1H), 3.56–3.45 (m, 1H), 3.19 (dd, *J* = 13.8, 6.9 Hz, 1H), 2.64–2.56 (m, 1H), 2.51 – 2.41 (m, 1H), 1.94 (dd, *J* = 10.3, 4.3 Hz, 1H), 1.67 (q, *J* = 7.6 Hz, 2H), 1.61 (s, 9H), 1.59–1.54 (m, 1H) ppm. HRMS (ESI^+) calc. for $C_{10}H_{20}NO_4$ $[MH]^+$ 230.1387, found 230.1385.



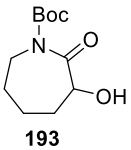
191

The title compound (**191**) was obtained as a white solid (4.1 mg, 10% yield) using the described general method [from **188** (0.20 mmol) and the variant R19/F87A (0.10 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (500 MHz, $CDCl_3$) δ 4.74 (s, 1H), 4.55 (tdd, *J* = 8.3, 6.5, 4.5 Hz, 1H), 3.29 (q, *J* = 6.5 Hz, 2H), 2.54 (dd, *J* = 9.6, 6.8 Hz, 2H), 2.38 (dq, *J* = 13.3, 6.7 Hz, 1H), 1.94–1.78 (m, 4H), 1.44 (s, 9H) ppm. HRMS (ESI^+) calc. for $C_{10}H_{20}NO_4$ $[MH]^+$ 230.1387, found 230.1386.



192

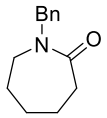
The title compound (**192**) was obtained as a white solid (3.5 mg, 8% yield) using the described general method [from **188** (0.20 mmol) and the variant K19/F87V (0.10 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (500 MHz, $CDCl_3$) δ 4.10 (q, *J* = 6.9, 6.0 Hz, 1H), 3.84 (dd, *J* = 15.3, 7.3 Hz, 1H), 3.74 (dd, *J* = 15.3, 8.8 Hz, 1H), 2.98–2.86 (m, 2H), 1.95 (t, *J* = 9.1 Hz, 2H), 1.86–1.78 (m, 1H), 1.77 (d, *J* = 3.9 Hz, 1H), 1.73–1.66 (m, 1H), 1.56 (s, 9H) ppm. HRMS (ESI^+) calc. for $C_{10}H_{20}NO_4$ $[MH]^+$ 230.1387, found 230.1385.



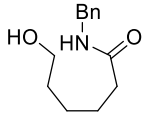
193

The title compound (**193**) was obtained as a white solid (5.0 mg, 12% yield) using the described general method [from **188** (0.20 mmol) and the variant R19/F87A (0.10 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (500 MHz, $CDCl_3$) δ 4.38 (ddd, *J* = 10.9, 4.8, 2.5 Hz, 1H), 4.36–4.28 (m, 1H), 4.02 (d, *J* = 4.8 Hz, 1H), 3.14 (dd, *J* = 15.5, 11.3 Hz, 1H), 2.07 (ddd, *J* = 13.7, 3.8, 2.0 Hz, 1H), 1.99–1.85 (m, 2H), 1.72 (dt, *J* = 12.7, 3.4 Hz, 1H), 1.69–1.61 (m, 2H), 1.56 (s, 9H), 1.46–1.35 (m, 1H) ppm. ^{13}C NMR (126 MHz, $CDCl_3$) δ

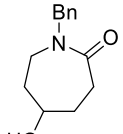
176.66, 152.29, 84.08, 71.74, 45.38, 34.06, 28.13, 28.02, 26.99 ppm. HRMS (ESI$^+$) calc. for $C_{10}H_{20}NO_4$ [MH]$^+$ 230.1387, found 230.1387.


194

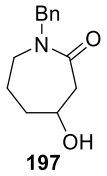
To a solution of ε-caprolactam (2.497 g, 22.1 mmol) in THF (50 mL) added NaH (1.3 g, 33.15 mmol) portionwise at −5° C., while keeping inner temperature between −5-0° C. After stirring for 30 min at 0° C, *N*-Benzyl bromide (3.4 mL) was added dropwise. The mixture was stirred at 16° C for 16 h. The mixture was poured into ice-water with stirring, extracted with ethyl acetate (100 mL × 2). The combined organic layer was dried over Na_2SO_4, concentrated to give the crude product, which was purified by chromatography on silica gel to give **194**[90] as colorless oil (71% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.39–7.15 (m, 5H), 4.59 (s, 2H), 3.33–3.21 (m, 2H), 2.65–2.53 (m, 2H), 1.70 (hept, *J* = 4.2, 3.8 Hz, 4H), 1.49 (q, *J* = 5.3 Hz, 2H) ppm. HRMS (ESI$^+$) calc. for $C_{13}H_{18}NO$ [MH]$^+$ 204.1383, found 204.1384.


195

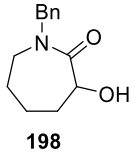
The title compound (**195**)[98] was obtained as a white solid (17.8 mg, 44% yield) using the described general method [from **194** (0.20 mmol) and the variant R1/I263G/L437VL (0.10 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.37–7.22 (m, 5H), 5.79 (s, 1H), 4.43 (d, *J* = 5.7 Hz, 2H), 3.64 (t, *J* = 6.5 Hz, 2H), 2.23 (t, *J* = 7.5 Hz, 2H), 1.70 (q, *J* = 7.3 Hz, 2H), 1.57 (h, *J* = 6.9 Hz, 2H), 1.41 (dq, *J* = 10.1, 7.6, 7.1 Hz, 2H) ppm. HRMS (ESI$^+$) calc. for $C_{13}H_{20}NO_2$ [MH]$^+$ 222.1489, found 222.1490.


196

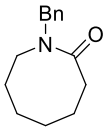
The title compound (**196**) was obtained as a white solid (2.8 mg, 7% yield) using the described general method [from **194** (0.20 mmol) and the variant R1/I263G/L437VL (0.10 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.37–7.19 (m, 5H), 4.67–4.52 (m, 2H), 4.00–3.90 (m, 1H), 3.61–3.50 (m, 1H), 3.13 (dd, *J* = 15.7, 8.6 Hz, 1H), 2.94–2.83 (m, 1H), 2.47–2.37 (m, 1H), 1.99 (t, *J* = 12.5 Hz, 1H), 1.81–1.72 (m, 2H), 1.53–1.45 (m, 1H) ppm. HRMS (ESI$^+$) calc. for $C_{13}H_{20}NO_2$ [MH]$^+$ 220.1332, found 220.1333.


197

The title compound (**197**)[99] was obtained as a white solid (0.2 mg, 1% yield) using the described general method [from **194** (0.20 mmol) and the variant I263G (0.10 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (500 MHz, $CDCl_3$) 7.27 (s, 5H), 4.59 (s, 2H), 4.20–3.60 (m, 2H), 3.29 (br, t, *J* = 4.4 Hz, 2H), 2.91 (dd, *J* = 16.2, 9.7 Hz, 1H), 2.90 (d, *J* = 4.4 Hz, 1H), 2.00–1.20 (m, 4H) ppm. HRMS (ESI$^+$) calc. for $C_{13}H_{20}NO_2$ [MH]$^+$ 220.1332, found 220.1332.

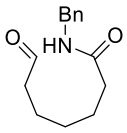

198

The title compound (**198**)[100] was obtained as a white solid (3.1 mg, 8% yield) using the described general method [from **194** (0.20 mmol) and the variant RT2/V78I/A184I/A330P (0.10 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.38–7.20 (m, 5H), 4.78 (d, *J* = 14.6 Hz, 1H), 4.54 (d, *J* = 14.6 Hz, 1H), 4.31 (dd, *J* = 11.4, 2.4 Hz, 1H), 3.33–3.14 (m, 2H), 2.07–2.01 (m, 1H), 1.97–1.90 (m, 1H), 1.70 (s, 1H), 1.68–1.58 (m, 1H), 1.58–1.47 (m, 1H), 1.23–1.11 (m, 1H) ppm. HRMS (ESI$^+$) calc. for $C_{13}H_{20}NO_2$ [MH]$^+$ 220.1332, found 220.1332.



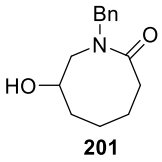
199

To a solution of ε-caprolactam (2.807 g, 22.1 mmol) in THF (50 mL) added NaH (1.3 g, 33.15 mmol) portionwise at −5° C., while keeping inner temperature between −5-0° C. After stirring for 30 min at 0° C, *N*-Benzyl bromide (3.4 mL) was added dropwise. The mixture was stirred at 16° C for 16 h. The mixture was poured into ice-water with stirring, extracted with ethyl acetate (100 mL × 2). The combined organic layer was dried over Na_2SO_4, concentrated to give the crude product, which was purified by chromatography on silica gel to give **199**[101] as colorless oil (65% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.36–7.23 (m, 5H), 4.59 (s, 2H), 3.43–3.38 (m, 2H), 2.60–2.54 (m, 2H), 1.85 (ddd, *J* = 9.1, 7.5, 4.2 Hz, 2H), 1.63–1.52 (m, 4H), 1.51–1.43 (m, 2H) ppm. HRMS (ESI$^+$) calc. for $C_{14}H_{20}NO$ $[MH]^+$ 218.1540, found 218.1540.



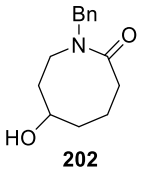
200

The title compound (**200**) was obtained as a white solid (7.2 mg, 17% yield) using the described general method [from **199** (0.20 mmol) and the variant K19/F87V/A328V (0.10 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (400 MHz, $CDCl_3$) δ 9.76 (t, *J* = 1.7 Hz, 1H), 7.44–7.24 (m, 5H), 5.67 (dd, *J* = 9.0, 5.2 Hz, 2H), 4.44 (d, *J* = 5.7 Hz, 2H), 2.44 (td, *J* = 7.3, 1.7 Hz, 2H), 2.22 (t, *J* = 7.5 Hz, 2H), 1.74–1.59 (m, 4H), 1.44–1.31 (m, 2H) ppm. HRMS (ESI$^+$) calc. for $C_{14}H_{20}NO_2$ $[MH]^+$ 234.1489, found 234.1490.



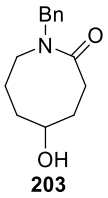
201

The title compound (**201**) was obtained as a white solid (4.5 mg, 10% yield) using the described general method [from **199** (0.20 mmol) and the variant RT2 (0.10 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.35–7.23 (m, 5H), 4.71 (q, *J* = 15.1, 14.3 Hz, 2H), 3.81 (tt, *J* = 7.5, 3.6 Hz, 1H), 3.46 (qd, *J* = 14.5, 13.5, 4.8 Hz, 2H), 2.64 (ddd, *J* = 13.3, 8.9, 4.5 Hz, 1H), 2.50 (ddd, *J* = 12.5, 7.5, 4.2 Hz, 1H), 1.89–1.82 (m, 2H), 1.79 (dt, *J* = 12.4, 3.5 Hz, 2H), 1.57 (ddt, *J* = 21.9, 9.0, 3.7 Hz, 2H), 1.37 (tq, *J* = 12.0, 7.7, 6.2 Hz, 1H) ppm. HRMS (ESI$^+$) calc. for $C_{14}H_{20}NO_2$ $[MH]^+$ 234.1489, found 234.1489.



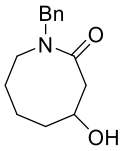
202

The title compound (**202**) was obtained as a white solid (3.1 mg, 7% yield) using the described general method [from **199** (0.20 mmol) and the variant RT2 (0.10 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.35–7.23 (m, 5H), 4.75 (d, *J* = 14.7 Hz, 1H), 4.48 (d, *J* = 14.7 Hz, 1H), 3.75 (d, *J* = 9.5 Hz, 1H), 3.57 (ddd, *J* = 15.9, 10.1, 3.3 Hz, 1H), 3.32 (dd, *J* = 15.9, 7.2 Hz, 2H), 2.57 (td, *J* = 7.9, 4.5 Hz, 2H), 2.01 (dddt, *J* = 14.1, 10.0, 7.9, 3.3 Hz, 2H), 1.86 (q, *J* = 5.6, 5.1 Hz, 1H), 1.84–1.80 (m, 2H), 1.52 (ddt, *J* = 13.5, 6.4, 3.1 Hz, 1H) ppm. HRMS (ESI$^+$) calc. for $C_{14}H_{20}NO_2$ $[MH]^+$ 234.1489, found 234.1489.



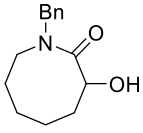
203

The title compound (**203**) was obtained as a white solid (12.1 mg, 28% yield) using the described general method [from **199** (0.20 mmol) and the variant K19/F87V/A328V (0.10 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.36–7.21 (m, 5H), 4.65–4.49 (m, 2H), 3.90–3.81 (m, 1H), 3.49–3.38 (m, 1H), 3.33 (ddd, *J* = 15.5, 7.8, 4.1 Hz, 1H), 2.74 (ddd, *J* = 13.4, 10.0, 3.6 Hz, 1H), 2.52 (ddd, *J* = 12.8, 8.7, 3.6 Hz, 1H), 2.19 (ddt, *J* = 13.7, 10.1, 3.7 Hz, 1H), 1.93–1.81 (m, 1H), 1.81–1.70 (m, 3H), 1.60 (ddt, *J* = 7.0, 5.0, 3.1 Hz, 1H) ppm. ^{13}C NMR (101 MHz, $CDCl_3$) δ 174.36, 137.74, 128.72, 128.47, 127.59, 71.04, 48.21, 46.79, 37.42, 33.70, 30.16, 25.23 ppm. HRMS (ESI$^+$) calc. for $C_{14}H_{20}NO_2$ $[MH]^+$ 234.1489, found 234.1487.



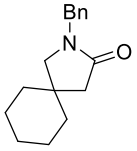
204

The title compound (**204**) was obtained as a white solid (10.2 mg, 23% yield) using the described general method [from **199** (0.20 mmol) and the variant K19/F87V/A328V (0.10 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.35–7.24 (m, 5H), 4.58 (q, *J* = 14.8 Hz, 2H), 4.10 (tt, *J* = 7.8, 3.8 Hz, 1H), 3.41 (ddd, *J* = 7.3, 4.7, 2.3 Hz, 2H), 2.92 (dd, *J* = 12.7, 3.6 Hz, 1H), 2.72 (dd, *J* = 12.7, 7.5 Hz, 1H), 1.91 (ddd, *J* = 14.3, 10.2, 4.0 Hz, 2H), 1.79–1.71 (m, 1H), 1.61–1.51 (m, 4H), 1.31–1.19 (m, 1H) ppm. HRMS (ESI$^+$) calc. for $C_{14}H_{20}NO_2$ $[MH]^+$ 234.1489, found 234.1489.



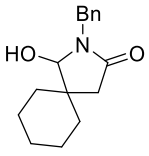
205

The title compound (**205**) was obtained as a white solid (3.2 mg, 7% yield) using the described general method [from **199** (0.20 mmol) and the variant K19/F87V/A328V (0.10 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.38–7.21 (m, 5H), 5.20 (d, *J* = 14.6 Hz, 1H), 4.48 (ddd, *J* = 11.6, 7.5, 4.1 Hz, 1H), 4.05 (d, *J* = 14.6 Hz, 1H), 3.99 (d, *J* = 7.5 Hz, 1H), 3.63–3.54 (m, 1H), 3.12 (ddd, *J* = 15.4, 4.8, 2.0 Hz, 1H), 2.14 (ddd, *J* = 13.7, 6.8, 3.6 Hz, 1H), 1.82–1.71 (m, 2H), 1.68 (dt, *J* = 9.5, 4.3 Hz, 1H), 1.63– 1.56 (m, 2H), 1.44–1.32 (m, 2H) ppm. HRMS (ESI$^+$) calc. for $C_{14}H_{20}NO_2$ $[MH]^+$ 234.1489, found 234.1489.



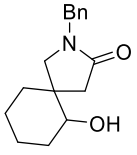
206

To a solution of ε-caprolactam (3.381 g, 22.1 mmol) in THF (50 mL) added NaH (1.3 g, 33.15 mmol) portionwise at −5° C., while keeping inner temperature between −5-0° C. After stirring for 30 min at 0° C, *N*-Benzyl bromide (3.4 mL) was added dropwise. The mixture was stirred at 16° C for 16 h. The mixture was poured into ice-water with stirring, extracted with ethyl acetate (100 mL × 2). The combined organic layer was dried over Na_2SO_4, concentrated to give the crude product, which was purified by chromatography on silica gel to give **206**[102] as colorless oil (72% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.39–7.22 (m, 5H), 4.46 (s, 2H), 3.02 (s, 2H), 2.33 (s, 2H), 1.56–1.32 (m, 10H) ppm. ^{13}C NMR (101 MHz, $CDCl_3$) δ 173.94, 136.59, 128.64, 128.05, 127.48, 58.04, 46.43, 44.02, 36.88, 36.12, 25.55, 22.76 ppm. HRMS (ESI$^+$) calc. for $C_{16}H_{22}NO$ $[MH]^+$ 244.1696, found 244.1696.



207

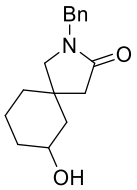
The title compound (**207**) was obtained as a white solid (12.0 mg, 25% yield) using the described general method [from **206** (0.20 mmol) and the variant RT2 (0.10 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.38–7.25 (m, 5H), 4.88 (d, *J* = 14.8 Hz, 1H), 4.55 (s, 1H), 4.15 (d, *J* = 14.8 Hz, 1H), 2.81 (s, 1H), 2.40–2.25 (m, 2H), 1.64–1.18 (m, 10H) ppm. ^{13}C NMR (101 MHz, $CDCl_3$) δ 174.55, 136.83, 128.85, 128.45, 127.75, 89.06, 43.89, 41.08, 40.68, 35.30, 31.71, 25.81, 23.01, 22.35 ppm. HRMS (ESI$^+$) calc. for $C_{16}H_{22}NO_2$ $[MH]^+$ 260.1646, found 260.1646.



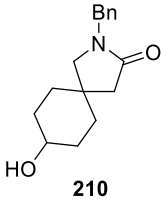
208

The title compound (**208**) was obtained as a white solid (1.2 mg, 2% yield) using the described general method [from **206** (0.20 mmol) and the variant R19/A328G/P329G/A330G (0.10 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. 5*R*,6*R*-**208** and/or 5*S*,6*S*-**208**: ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.36–7.28 (m, 3H), 7.23–7.21 (m, 2H), 4.53–4.37 (m, 2H), 3.42 (dd, *J* = 9.6, 3.6 Hz, 1H), 3.36 (d, *J* = 9.6 Hz, 1H), 2.85 (d, *J* = 9.6 Hz, 1H), 2.68 (d, *J* = 17.0 Hz, 1H), 2.21 (d, *J* = 16.9 Hz, 1H), 1.72 (d, *J* = 14.3 Hz, 3H), 1.39–1.23 (m, 5H) ppm. 5*S*,6*R*-**208** and/or 5*R*,6*S*-**208**: ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.38–7.30 (m, 5H), 4.52 (d, *J* = 14.7 Hz, 1H), 4.39 (d, *J* = 14.8 Hz, 1H), 3.57–3.51 (m, 1H), 3.38 (d,

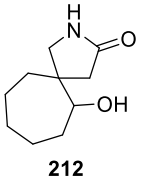
J = 9.1 Hz, 1H), 2.91 (d, *J* = 10.0 Hz, 1H), 2.60 (d, *J* = 16.9 Hz, 1H), 2.25 (d, *J* = 16.9 Hz, 1H), 1.76–0.98 (m, 8H) ppm. HRMS (ESI$^+$) calc. for $C_{16}H_{22}NO_2$ [MH]$^+$ 260.1646, found 260.1644.


209

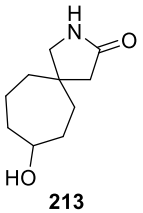
The title compound (**209**) was obtained as a white solid (1.5 mg, 3% yield) using the described general method [from **206** (0.20 mmol) and the variant R19/F87I (0.10 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.37–7.28 (m, 3H), 7.25–7.17 (m, 2H), 4.52–4.37 (m, 2H), 3.56 (dd, *J* = 9.4, 5.2 Hz, 1H), 3.08–2.95 (m, 2H), 2.45–2.28 (m, 2H), 1.95–1.81 (m, 2H), 1.69 (q, *J* = 3.8 Hz, 1H), 1.35 (dd, *J* = 12.8, 10.4 Hz, 1H), 1.23 (dddd, *J* = 21.2, 19.2, 12.0, 9.1 Hz, 3H) ppm. HRMS (ESI$^+$) calc. for $C_{16}H_{22}NO_2$ [MH]$^+$ 260.1646, found 260.1646.


210

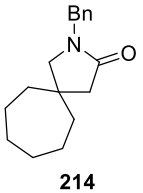
The title compound (**210**) was obtained as a white solid (4.5 mg, 9% yield) using the described general method [from **206** (0.20 mmol) and the variant R19/F87I (0.10 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.36–7.27 (m, 3H), 7.24–7.19 (m, 2H), 4.43 (s, 2H), 3.63 (tt, *J* = 9.3, 3.9 Hz, 1H), 2.98 (s, 2H), 2.37 (s, 2H), 1.79 (dd, *J* = 10.6, 5.1 Hz, 2H), 1.75–1.66 (m, 4H), 1.36 (dddd, *J* = 26.0, 14.7, 10.5, 3.0 Hz, 4H) ppm. ^{13}C NMR (101 MHz, $CDCl_3$) δ 173.78, 136.53, 128.84, 128.22, 127.73, 69.29, 58.53, 46.58, 42.66, 35.70, 34.15, 31.58 ppm. HRMS (ESI$^+$) calc. for $C_{16}H_{22}NO_2$ [MH]$^+$ 260.1646, found 260.1646.


212

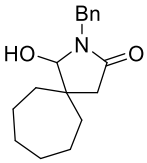
The title compound (**212**) was obtained as a white solid (5.3 mg, 32% yield) using the described general method [from **211** (0.10 mmol) and the variant GV/A184I (0.10 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. 5*R*,6*S*-**212** and/or 5*S*,6*R*-**212**: ^{1}H NMR (500 MHz, $CDCl_3$) δ 5.58 (s, 1H), 3.71 (dd, *J* = 7.6, 2.5 Hz, 1H), 3.56 (d, *J* = 9.7 Hz, 1H), 3.10–3.06 (m, 1H), 2.41 (d, *J* = 16.8 Hz, 1H), 2.22–2.15 (m, 1H), 1.88–1.81 (m, 1H), 1.75–1.65 (m, 3H), 1.65–1.44 (m, 8H) ppm. HRMS (ESI$^+$) calc. for $C_{10}H_{18}NO_2$ [MH]$^+$ 184.1333, found 184.1332.


213

The title compound (**213**) was obtained as a white solid (0.3 mg in the mixture of **212** and **213**, 2% yield) using the described general method [from **211** (0.10 mmol) and the variant GV/A184I (0.10 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (500 MHz, $CDCl_3$) δ 3.96–3.87 (m, 1H), 3.16 (q, *J* = 9.4 Hz, 2H), 2.17 (s, 5H), 2.02–1.40 (m, 10H) ppm. HRMS (ESI$^+$) calc. for $C_{10}H_{18}NO_2$ [MH]$^+$ 184.1333, found 184.1330.

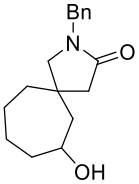

214

To a solution of ε-caprolactam (369 mg, 2.21 mmol) in THF (10 mL) added NaH (132 mg, 3.32 mmol) portionwise at −5° C., while keeping inner temperature between −5-0° C. After stirring for 30 min at 0° C, *N*-Benzyl bromide (340 μL) was added dropwise. The mixture was stirred at 16° C for 16 h. The mixture was poured into ice-water with stirring, extracted with ethyl acetate (10 mL × 2). The combined organic layer was dried over Na_2SO_4, concentrated to give the crude product, which was purified by chromatography on silica gel to give **214**[103] as colorless oil (72% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.37–7.19 (m, 2H), 4.43 (s, 1H), 2.98 (s, 1H), 2.31 (s, 1H), 1.65–1.46 (m, 3H), 1.44 (dq, *J* = 7.3, 3.6 Hz, 2H) ppm. ^{13}C NMR (101 MHz, $CDCl_3$) δ 174.41, 136.74, 128.79, 128.28, 127.65, 59.52, 46.65, 46.09, 40.20, 39.81, 28.93, 23.27 ppm. HRMS (ESI$^+$) calc. for $C_{17}H_{24}NO$ [MH]$^+$ 258.1853, found 258.1852.



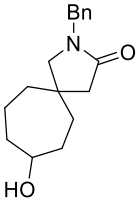
215

The title compound (**215**) was obtained as a white solid (7.2 mg, 14% yield) using the described general method [from **214** (0.20 mmol) and the variant R19/F87A/A328G/P329G/A330G (0.10 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.37–7.22 (m, 5H), 4.86 (d, *J* = 14.8 Hz, 1H), 4.51 (s, 1H), 4.14 (d, *J* = 14.8 Hz, 2H), 2.78 (s, 1H), 2.30 (dd, *J* = 59.4, 17.2 Hz, 2H), 1.87–1.76 (m, 1H), 1.63–1.25 (m, 11H) ppm. HRMS (ESI$^+$) calc. for $C_{17}H_{24}NO_2$ $[MH]^+$ 274.1802, found 274.1802.



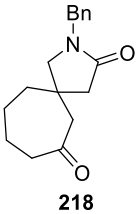
216

The title compound (**216**) was obtained as a white solid (0.4 mg of b*-OH and 3.2 mg of b-OH, 1% and 6% yield) using the described general method [from **214** (0.20 mmol) and the variants GVQ/V78L/I263G and GV/A184I (0.10 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. 5*R*,7*S*/5*S*,7*R*-**216** (b*-OH): ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.36–7.25 (m, 3H), 7.26–7.21 (m, 2H), 4.43 (q, *J* = 14.7 Hz, 2H), 3.90–3.81 (m, 1H), 3.03 (dd, *J* = 24.7, 10.0 Hz, 2H), 2.41 (dd, *J* = 24.6, 16.8 Hz, 2H), 2.09–1.23 (m, 10H) ppm. 5*R*,7*R*/5*S*,7*S*-**216** (b-OH): ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.35–7.26 (m, 3H), 7.21 (dt, *J* = 5.9, 1.6 Hz, 2H), 4.42 (dd, *J* = 34.3, 14.6 Hz, 2H), 3.69 (tdd, *J* = 9.4, 3.7, 2.5 Hz, 1H), 3.10 (d, *J* = 9.7 Hz, 1H), 3.00 (d, *J* = 9.8 Hz, 1H), 2.34 (dd, *J* = 24.8, 16.7 Hz, 2H), 1.90–1.84 (m, 1H), 1.75 (dd, *J* = 9.7, 4.2 Hz, 1H), 1.72–1.64 (m, 2H), 1.60–1.25 (m, 6H) ppm. HRMS (ESI$^+$) calc. for $C_{17}H_{24}NO_2$ $[MH]^+$ 274.1802, found 274.1802.



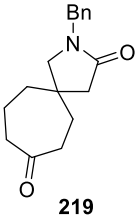
217

The title compound (**217**) was obtained as a white solid (4.8 mg of c-OH and 0.4 mg of c*-OH, 1% and 9% yield) using the described general method [from **214** (0.20 mmol) and the variants GVQ/V78L/I263G and GV/A184I (0.10 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. 5*R*,7*S*/5*S*,7*R*-**217** (c-OH): ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.33 (t, *J* = 7.2 Hz, 2H), 7.29 (d, *J* = 6.9 Hz, 1H), 7.24–7.21 (m, 2H), 4.43 (s, 2H), 3.89 (s, 1H), 3.01 (q, *J* = 9.7 Hz, 2H), 2.29 (s, 2H), 2.00–1.93 (m, 1H), 1.79–1.73 (m, 2H), 1.69–1.41 (m, 6H), 1.37–1.24 (m, 1H) ppm. 5*R*,7*R*/5*S*,7*S*-**217** (c*-OH): ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.31 (dddd, *J* = 14.1, 7.1, 4.5, 2.2 Hz, 3H), 7.24–7.20 (m, 2H), 4.42 (s, 2H), 3.87–3.78 (m, 1H), 2.96 (s, 2H), 2.40–2.27 (m, 2H), 1.95 (tt, *J* = 9.1, 5.8 Hz, 1H), 1.82–1.70 (m, 2H), 1.63–1.47 (m, 5H), 1.43–1.24 (m, 2H) ppm. HRMS (ESI$^+$) calc. for $C_{17}H_{24}NO_2$ $[MH]^+$ 274.1802, found 274.1802.



218

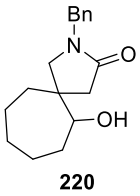
The title compound (**218**) was obtained as a white solid (4.1 mg, 8% yield) using the described general method [from **214** (0.20 mmol) and the variant GVQ/V78L/I263G (0.10 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.36–7.27 (m, 3H), 7.24–7.20 (m, 2H), 4.53 (d, *J* = 14.7 Hz, 1H), 4.33 (d, *J* = 14.7 Hz, 1H), 3.09 (d, *J* = 10.1 Hz, 1H), 2.95 (d, *J* = 9.9 Hz, 1H), 2.67 (d, *J* = 12.5 Hz, 1H), 2.60 (d, *J* = 12.6 Hz, 1H), 2.51–2.39 (m, 2H), 2.39–2.27 (m, 2H), 1.83–1.47 (m, 6H) ppm. HRMS (ESI$^+$) calc. for $C_{17}H_{22}NO_2$ $[MH]^+$ 272.1646, found 272.1646.



219

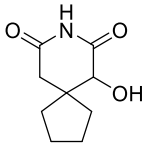
The title compound (**219**) was obtained as a white solid (2.6 mg, 5% yield) using the described general method [from **214** (0.20 mmol) and the variant GVQ/V78L/I263G (0.10 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.36–7.28 (m, 3H), 7.23 (dd, *J* = 5.2, 1.7 Hz, 2H), 4.44 (d, *J* = 2.8 Hz, 2H), 3.04

(d, J = 1.3 Hz, 2H), 2.52–2.39 (m, 4H), 2.38 (s, 2H), 1.83–1.48 (m, 6H) ppm. HRMS (ESI^+) calc. for $C_{17}H_{22}NO_2$ $[MH]^+$ 272.1646, found 272.1646.



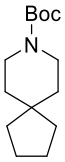
220

The title compound (**220**) was obtained as a white solid (6.9 mg, 13% yield) using the described general method [from **214** (0.20 mmol) and the variant R19/P329G/A330W (0.10 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. ^1H NMR (400 MHz, $CDCl_3$) δ 7.34–7.24 (m, 3H), 7.24–7.21 (m, 2H), 4.51 (d, J = 14.7 Hz, 1H), 4.34 (d, J = 14.7 Hz, 1H), 3.50–3.46 (m, 2H), 3.32 (d, J = 9.5 Hz, 1H), 2.87 (d, J = 9.5 Hz, 1H), 2.78 (d, J = 16.9 Hz, 1H), 2.17 (d, J = 16.9 Hz, 1H), 1.74–1.23 (m, 10H) ppm. HRMS (ESI^+) calc. for $C_{17}H_{24}NO_2$ $[MH]^+$ 274.1802, found 274.1802.



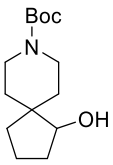
223

The title compound (**223**) was obtained as a white solid (5.7 mg, 17% yield) using the described general method [from **222** (0.20 mmol) and the variant K19/A82M/F87A/A330W (0.10 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. ^1H NMR (400 MHz, $CDCl_3$) δ 4.24 (s, 1H), 3.40 (s, 1H), 2.75 (d, J = 17.5 Hz, 1H), 2.54 (d, J = 17.4 Hz, 1H), 2.12–2.04 (m, 1H), 1.79–1.63 (m, 5H), 1.46–1.38 (m, 1H), 1.33–1.24 (m, 1H) ppm. ^{13}C NMR (101 MHz, $CDCl_3$) δ 174.72, 171.06, 74.06, 45.73, 44.30, 36.05, 30.14, 26.03, 25.67 ppm. HRMS (ESI^+) calc. for $C_9H_{14}NO_3$ $[MH]^+$ 184.0969, found 184.0969.



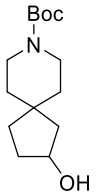
224

To a solution of lithium aluminium hydride (1.14 g, 29.9 mmol) in tetrahydrofuran (60 mL) at 0 °C was added **222** (1.00 g, 5.98 mmol) in tetrahydrofuran (30 mL) dropwise under a nitrogen atmosphere. The reaction was allowed to warm to room temperature over 30 minutes and then refluxed overnight. The solution was cooled to 0 °C and quenched with water (1.14 mL), 15% sodium hydroxide (1.14 mL) and water (3.42 mL) sequentially. The resulting slurry was filtered and the filtrate diluted with dichloromethane, washed with brine, dried over magnesium sulfate, filtered and concentrated *in vacuo*. To the resulting crude oil (400 mg, 2.87 mmol) dissolved in anhydrous dichloromethane (6 mL) was added triethylamine (0.42 mL, 3.01 mmol), followed by di-tert-butyl-dicarbonate (877 mg, 4.02 mmol in 2 mL dichloromethane). The mixture was stirred at ambient temperature for 2 hours. Tetrahydrofuran was removed *in vacuo*, and the crude was extracted by ethyl acetate (3 × 100 mL) and dried by anhydrous Na_2SO_4. The combined organic layers were purified by silica gel chromatography (petrol/EtOAc, 1:1) to afford a colourless oil **224**[104] (500 mg, 43%). ^1H NMR (400 MHz, $CDCl_3$) δ 3.39–3.32 (m, 4H), 1.61 (dq, J = 7.3, 3.6 Hz, 4H), 1.45 (s, 9H), 1.45–1.37 (m, 8H) ppm. HRMS (ESI^+) calc. for $C_{14}H_{25}NO_2Na$ $[MNa]^+$ 262.1778, found 262.1778.



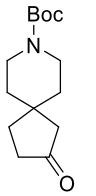
225

The title compound (**225**)[105] was obtained as a white solid (3.2 mg, 7% yield) using the described general method [from **224** (0.20 mmol) and the variant RP/F87V (0.10 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. ^1H NMR (400 MHz, $CDCl_3$) δ 3.84–3.69 (m, 3H), 3.04 (ddd, J = 13.7, 10.4, 3.4 Hz, 2H), 2.03–1.97 (m, 1H), 1.83–1.73 (m, 1H), 1.68–1.59 (m, 4H), 1.50–1.37 (m, 13H) ppm. HRMS (ESI^+) calc. for $C_{14}H_{26}NO_3$ $[MH]^+$ 256.1908, found 256.1908.



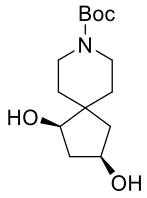
226

The title compound (**226**)[106] was obtained as a white solid (7.8 mg, 17% yield) using the described general method [from **224** (0.20 mmol) and the variant RP/F87V (0.10 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (400 MHz, $CDCl_3$) δ 4.37 (tt, *J* = 5.9, 4.1 Hz, 1H), 3.42–3.27 (m, 4H), 1.98–1.86 (m, 1H), 1.80 (dd, *J* = 13.7, 6.4 Hz, 1H), 1.74–1.65 (m, 2H), 1.55 (t, *J* = 6.9 Hz, 2H), 1.53–1.48 (m, 2H), 1.45 (s, 9H), 1.38 (t, *J* = 5.8 Hz, 2H) ppm. HRMS (ESI^+) calc. for $C_{14}H_{26}NO_3$ $[MH]^+$ 256.1908, found 256.1908.



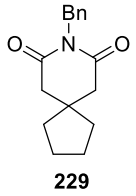
227

The title compound (**227**)[107] was obtained as a white solid (7.8 mg, 17% yield) using the described general method [from **224** (0.20 mmol) and the variant RP/F87V (0.10 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (400 MHz, $CDCl_3$) δ 3.65–3.56 (m, 2H), 3.20 (ddd, *J* = 13.2, 7.6, 5.0 Hz, 2H), 2.30 (t, *J* = 7.9 Hz, 2H), 2.16 (s, 2H), 1.87 (t, *J* = 8.0 Hz, 2H), 1.55 – 1.49 (m, 4H), 1.46 (s, 9H) ppm. HRMS (ESI^+) calc. for $C_{14}H_{24}NO_3$ $[MH]^+$ 254.1751, found 254.1751.



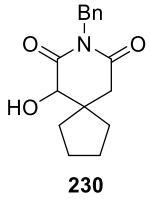
228

The title compound (**228**) was obtained as a white solid (6.8 mg, 14% yield) using the described general method [from **224** (0.20 mmol) and the variant RP/F87V (0.10 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (400 MHz, $CDCl_3$) δ 4.57–4.47 (m, 1H), 4.00 (t, *J* = 5.6 Hz, 1H), 3.84 (s, 2H), 2.98 (dt, *J* = 22.0, 11.4 Hz, 2H), 2.09 (dd, *J* = 14.1, 7.7 Hz, 1H), 2.06–1.99 (m, 2H), 1.64–1.55 (m, 2H), 1.53 (dd, *J* = 14.0, 3.6 Hz, 1H), 1.45 (s, 9H), 1.33 (d, *J* = 18.1 Hz, 2H) ppm. HRMS (ESI^+) calc. for $C_{14}H_{26}NO_4$ $[MH]^+$ 272.1857, found 272.1857.



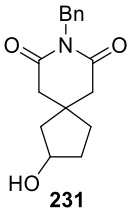
229

To a solution of ε-caprolactam (3.69 g, 22.1 mmol) in THF (50 mL) added NaH (1.32 g, 33.2 mmol) portionwise at −5° C., while keeping inner temperature between −5-0° C. After stirring for 30 min at 0° C, *N*-Benzyl bromide (3.4 mL) was added dropwise. The mixture was stirred at 16° C for 72 h. The mixture was poured into ice-water with stirring, extracted with ethyl acetate (100 mL × 2). The combined organic layer was dried over Na_2SO_4, concentrated to give the crude product, which was purified by chromatography on silica gel to give **229**[90] as white solid (76% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.36–7.32 (m, 2H), 7.31–7.21 (m, 3H), 4.95 (s, 2H), 2.61 (s, 4H), 1.72–1.66 (m, 4H), 1.48 (tdd, *J* = 7.3, 3.4, 1.6 Hz, 4H) ppm. ^{13}C NMR (101 MHz, $CDCl_3$) δ 172.29, 137.44, 128.75, 128.51, 127.50, 45.05, 42.87, 39.66, 37.72, 24.34 ppm. HRMS (ESI^+) calc. for $C_{16}H_{20}NO_2$ $[MH]^+$ 258.1489, found 258.1489.



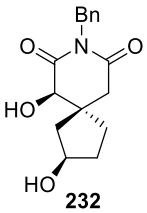
230

The title compound (**230**) was obtained as a white solid (2.2 mg, 4% yield) using the described general method [from **229** (0.20 mmol) and the variant R19/F87I (0.10 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.36–7.22 (m, 5H), 4.93 (s, 2H), 4.22 (d, *J* = 1.3 Hz, 1H), 3.50 (d, *J* = 1.7 Hz, 1H), 2.69 (dd, *J* = 133.2, 17.5 Hz, 2H), 2.07 (dt, *J* = 12.7, 7.2 Hz, 1H), 1.75–1.57 (m, 5H), 1.38 (dt, *J* = 12.5, 6.4 Hz, 1H), 1.19–1.12 (m, 1H) ppm. ^{13}C NMR (126 MHz, $CDCl_3$) δ 175.19, 170.73, 136.54, 128.60, 128.48, 127.65, 74.37, 44.74, 44.63, 43.71, 36.00, 29.67, 25.92, 25.46 ppm. HRMS (ESI^+) calc. for $C_{16}H_{20}NO_3$ $[MH]^+$ 274.1438, found 274.1438.



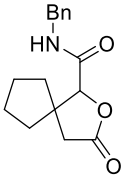
231

The title compound (**231**) was obtained as a white solid (7.6 mg, 15% yield) using the described general method [from **229** (0.20 mmol) and the variant R19/F87I (0.10 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.37–7.27 (m, 4H), 7.25–7.19 (m, 1H), 4.95 (s, 2H), 4.41 (tt, *J* = 5.8, 3.1 Hz, 1H), 2.81 (s, 2H), 2.60 (d, *J* = 2.9 Hz, 2H), 2.00–1.90 (m, 1H), 1.84–1.70 (m, 4H), 1.59–1.54 (m, 1H), 1.52 (td, *J* = 7.6, 7.1, 4.2 Hz, 1H), 1.46 (d, *J* = 3.0 Hz, 1H) ppm. ^{13}C NMR (126 MHz, $CDCl_3$) δ 172.07, 171.96, 137.37, 128.78, 128.53, 127.55, 73.36, 47.08, 46.30, 45.87, 42.90, 38.82, 35.64, 34.77 ppm. HRMS (ESI$^+$) calc. for $C_{16}H_{20}NO_3$ $[MH]^+$ 274.1438, found 274.1438.



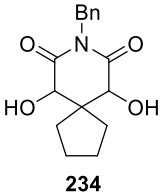
232

The title compound (**232**) was obtained as a white solid (8.2 mg, 16% yield) using the described general method [from **229** (0.20 mmol) and the variant GV/A184I (0.10 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.33–7.24 (m, 5H), 4.93 (s, 2H), 4.43 (tt, *J* = 5.1, 2.3 Hz, 1H), 4.17 (d, *J* = 1.5 Hz, 1H), 3.55 (d, *J* = 1.6 Hz, 1H), 3.16 (d, *J* = 17.6 Hz, 1H), 2.68 (d, *J* = 17.6 Hz, 1H), 2.12–2.03 (m, 1H), 1.92 (dp, *J* = 12.8, 4.8, 4.3 Hz, 1H), 1.85 (dd, *J* = 13.6, 5.4 Hz, 1H), 1.79–1.67 (m, 2H), 1.37 (d, *J* = 2.6 Hz, 1H), 1.23 (dt, *J* = 13.7, 2.1 Hz, 1H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 175.11, 170.85, 136.65, 128.78, 128.66, 127.85, 75.18, 74.84, 45.87, 44.14, 43.91, 39.03, 35.47, 34.17 ppm. HRMS (ESI$^+$) calc. for $C_{16}H_{20}NO_4$ $[MH]^+$ 290.1387, found 290.1387.



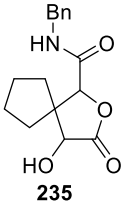
233

The title compound (**233**) was obtained as a white solid (10.1 mg, 20% yield) using the described general method [from **229** (0.20 mmol) and the variant R19/S72A/A330W (0.10 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.37–7.26 (m, 5H), 4.78 (s, 1H), 4.47 (d, *J* = 5.9 Hz, 2H), 2.56–2.39 (m, 2H), 2.25 (dddd, *J* = 15.7, 11.6, 6.0, 1.8 Hz, 1H), 1.84–1.56 (m, 5H), 1.47–1.38 (m, 1H) ppm. ^{13}C NMR (101 MHz, $CDCl_3$) δ 174.55, 167.39, 137.47, 128.95, 128.10, 127.94, 83.76, 51.10, 43.24, 43.13, 36.61, 32.77, 24.18, 23.57 ppm. HRMS (ESI$^+$) calc. for $C_{16}H_{20}NO_3$ $[MH]^+$ 274.1438, found 274.1438.



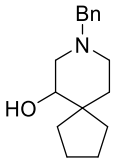
234

The title compound (**234**) was obtained as a white solid (1.8 mg, 3% yield) using the described general method [from **229** (0.20 mmol) and the variant GV/A184I (0.10 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.30 (d, *J* = 4.5 Hz, 5H), 4.94 (d, *J* = 4.0 Hz, 2H), 4.37 (d, *J* = 2.6 Hz, 2H), 2.96 (d, *J* = 2.7 Hz, 2H), 1.82–1.73 (m, 3H), 1.64 (p, *J* = 7.4, 6.6 Hz, 6H), 1.54–1.46 (m, 3H) ppm. HRMS (ESI$^+$) calc. for $C_{16}H_{20}NO_4$ $[MH]^+$ 290.1387, found 290.1387.



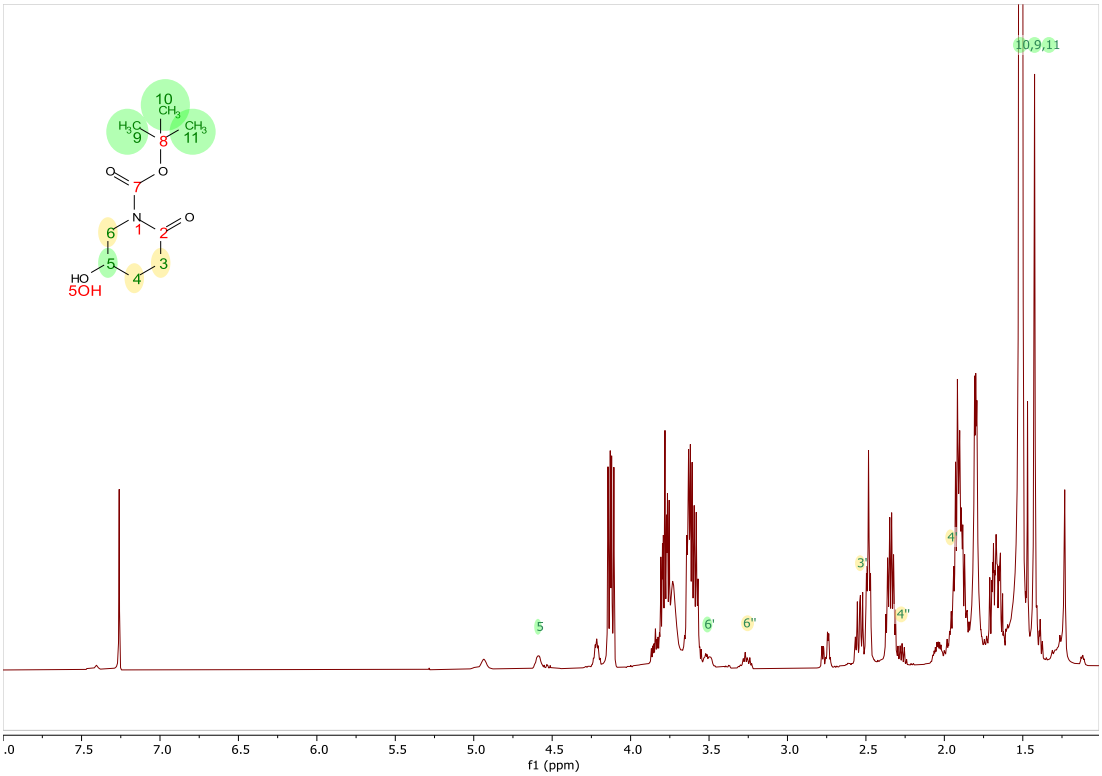
235

The title compound (**235**) was obtained as a white solid (2.3 mg, 4% yield) using the described general method [from **229** (0.20 mmol) and the variant GV/A184I (0.10 μmol) in phosphate buffer, 20.0 mL reaction volume] and purification by silica gel chromatography. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.37–7.27 (m, 5H), 6.69 (s, 1H), 4.69 (s, 1H), 4.49 (dd, *J* = 5.8, 1.7 Hz, 2H), 4.30 (d, *J* = 4.2 Hz, 1H), 2.80 (d, *J* = 4.2 Hz, 1H), 2.35 (dt, *J* = 15.4, 7.6 Hz, 1H), 1.91 (dt, *J* = 12.6, 6.3 Hz, 1H), 1.75 (ddd, *J* = 54.2, 12.6, 6.8 Hz, 5H), 1.37 (dt, *J* = 13.6, 7.1 Hz, 1H) ppm. HRMS (ESI$^+$) calc. for $C_{16}H_{20}NO_4$ $[MH]^+$ 290.1387, found 290.1387.

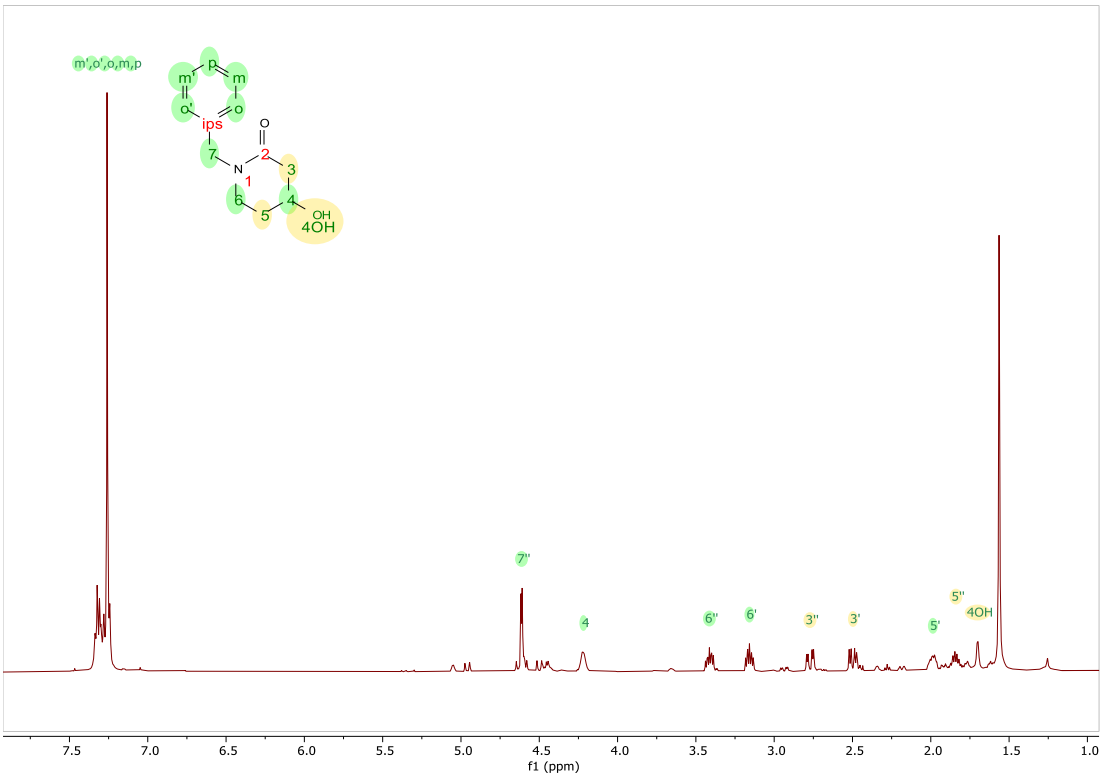


236

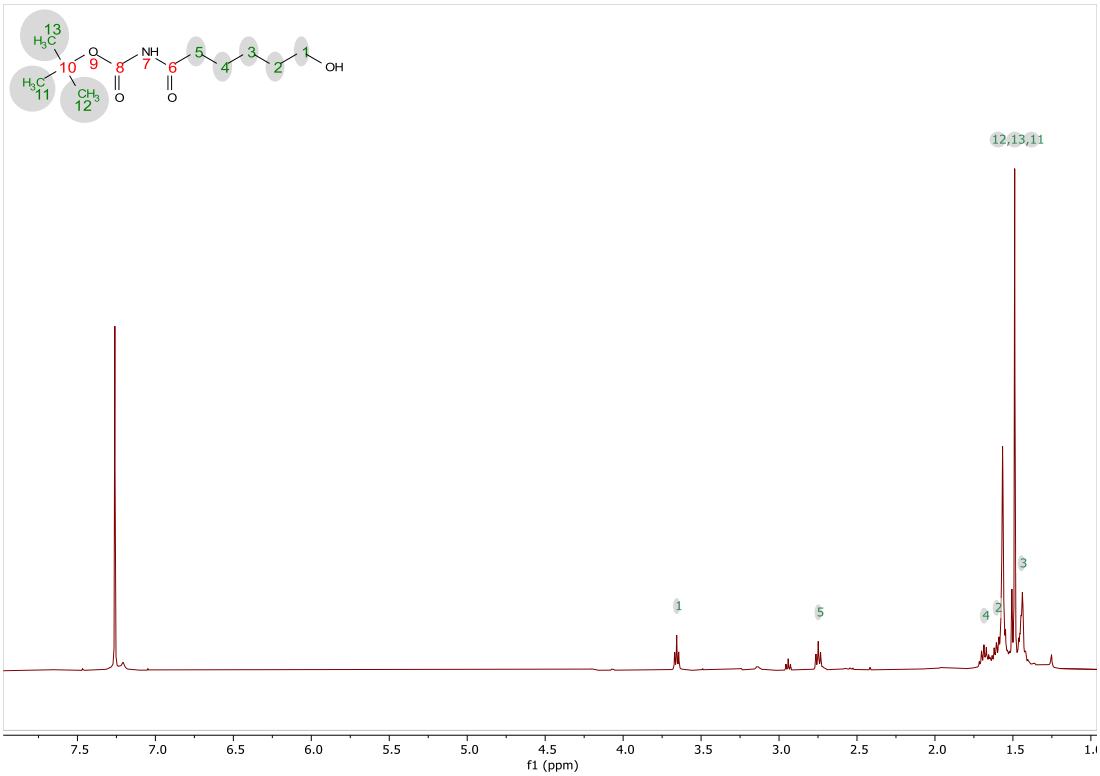
To a solution of lithium aluminium hydride (6.954 mg, 183 μmol) in tetrahydrofuran (10 mL) at 0 °C was added **230** (10.0 mg, 36.6 μmol) in tetrahydrofuran (5 mL) dropwise under a nitrogen atmosphere. The reaction was allowed to warm to room temperature over 30 minutes and then refluxed overnight. The solution was cooled to 0 °C and quenched with water (6.99 μL), 15% sodium hydroxide (6.99 μL) and water (6.99 μL) sequentially. The resulting slurry was filtered and the filtrate diluted with dichloromethane, washed with brine, dried over magnesium sulfate, filtered and concentrated *in vacuo* to yield **236** (35%). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.36–7.27 (m, 5H), 3.50 (d, *J* = 3.4 Hz, 2H), 3.32–3.26 (m, 1H), 2.71 (d, *J* = 11.3 Hz, 2H), 2.59 (d, *J* = 11.7 Hz, 1H), 2.37 (d, *J* = 11.4 Hz, 1H), 2.12 (t, *J* = 11.5 Hz, 1H), 1.78–1.70 (m, 1H), 1.68–1.44 (m, 8H), 1.31–1.27 (m, 1H) ppm. ^{13}C NMR (101 MHz, $CDCl_3$) δ 138.27, 128.95, 128.26, 127.09, 73.17, 62.63, 57.00, 50.54, 45.46, 34.27, 25.39, 24.70 ppm. HRMS (ESI^+) calc. for $C_{16}H_{20}NO_3$ $[MH]^+$ 274.1438, found 274.1438.



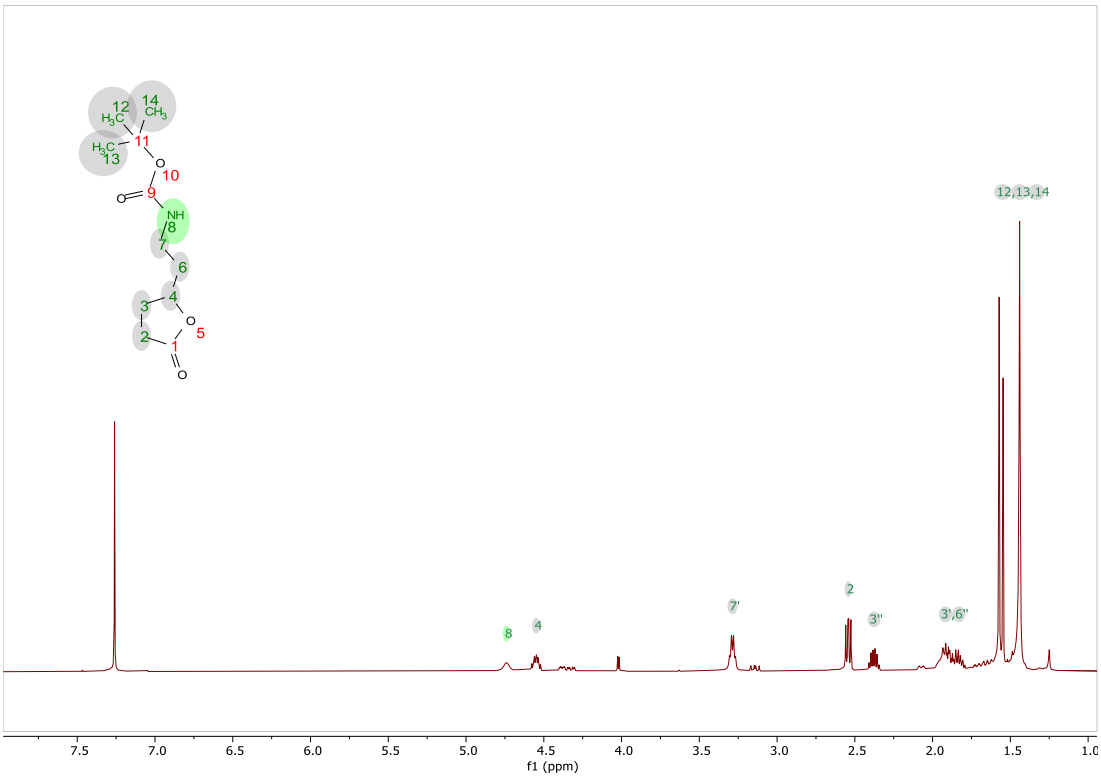
Spectrum 115 The ^{1}H NMR of **178**.



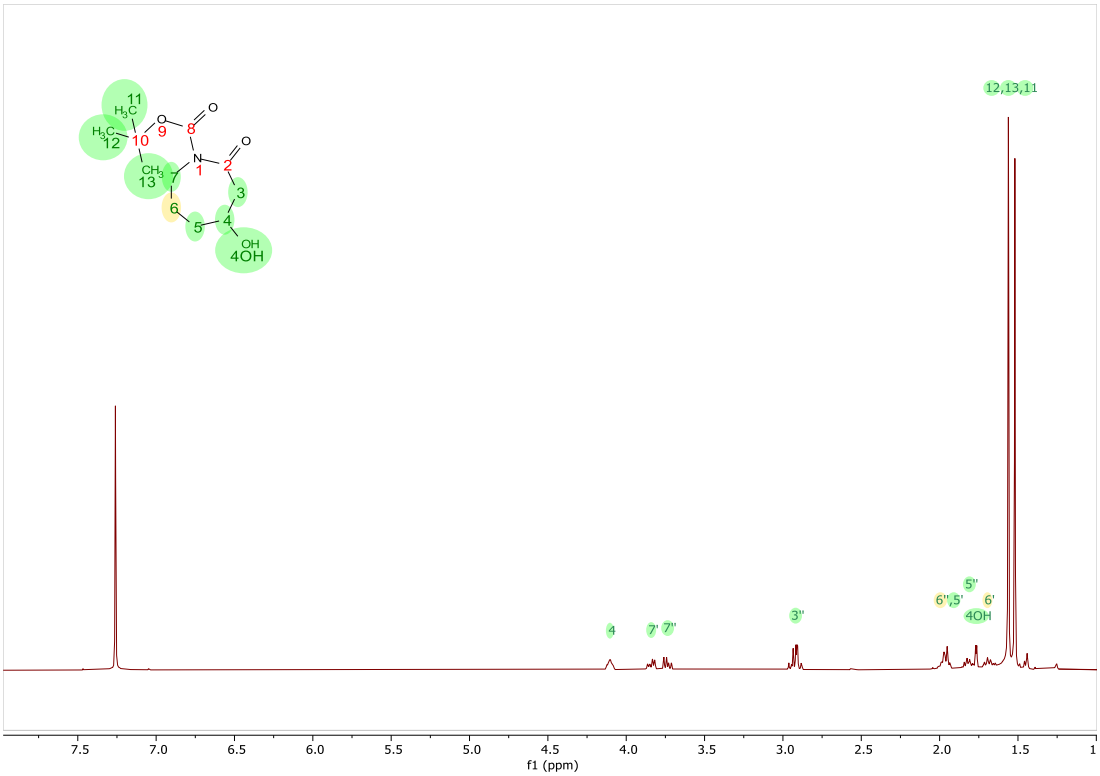
Spectrum 116 The ^{1}H NMR of **184**.



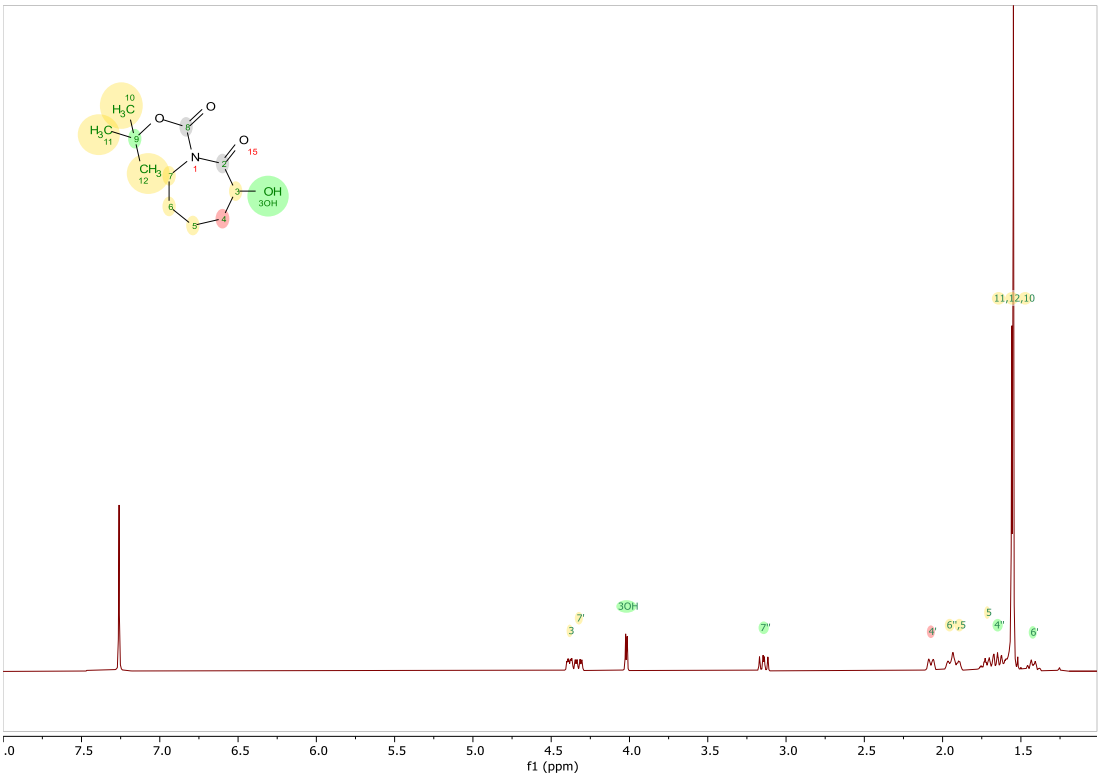
Spectrum 117 The ^{1}H NMR of **189**.



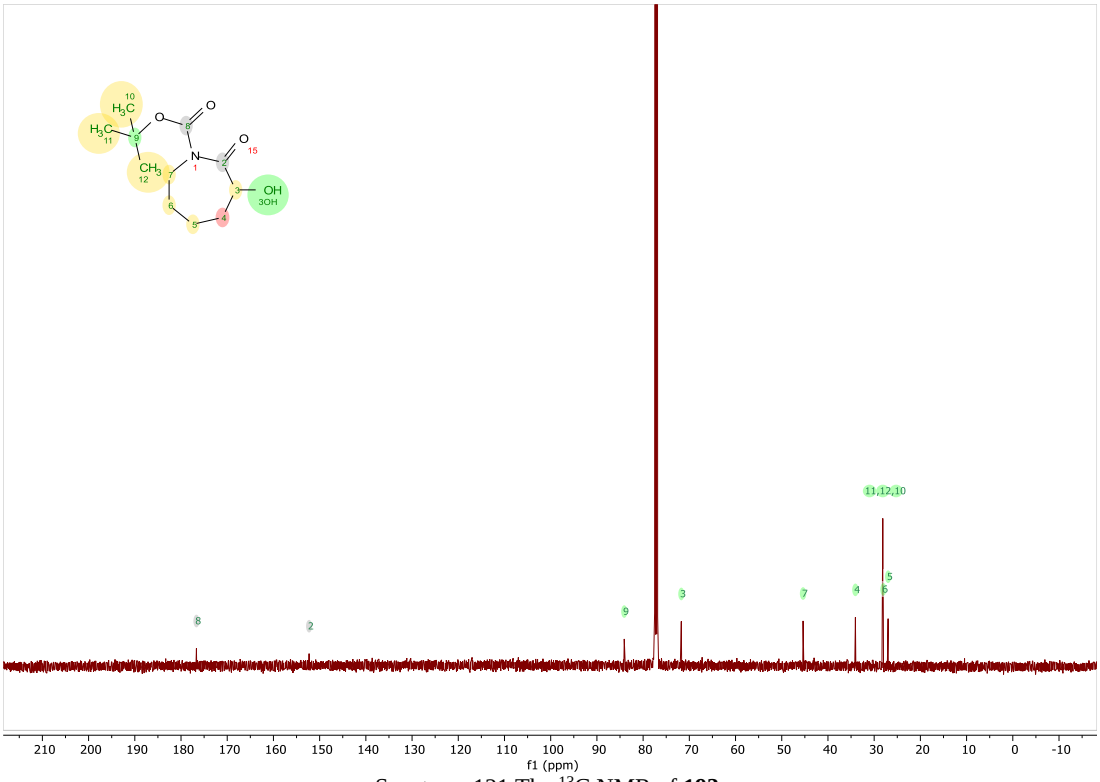
Spectrum 118 The ^{1}H NMR of **191**.



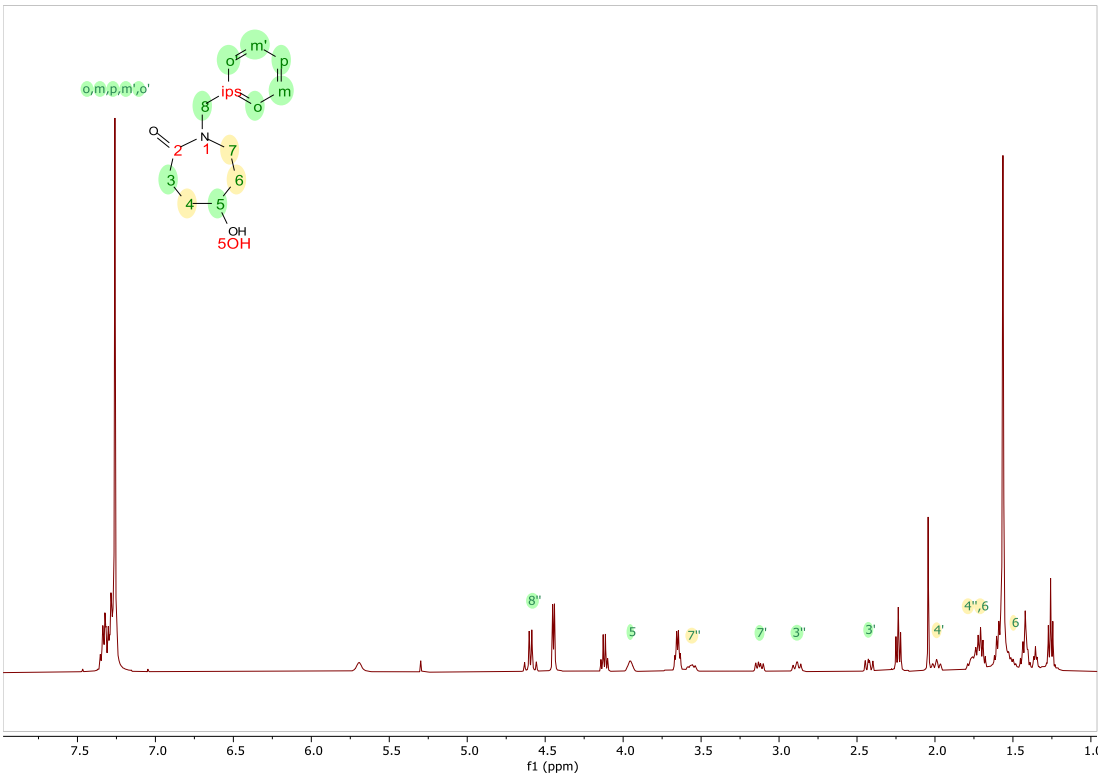
Spectrum 119 The ^{1}H NMR of **192**.



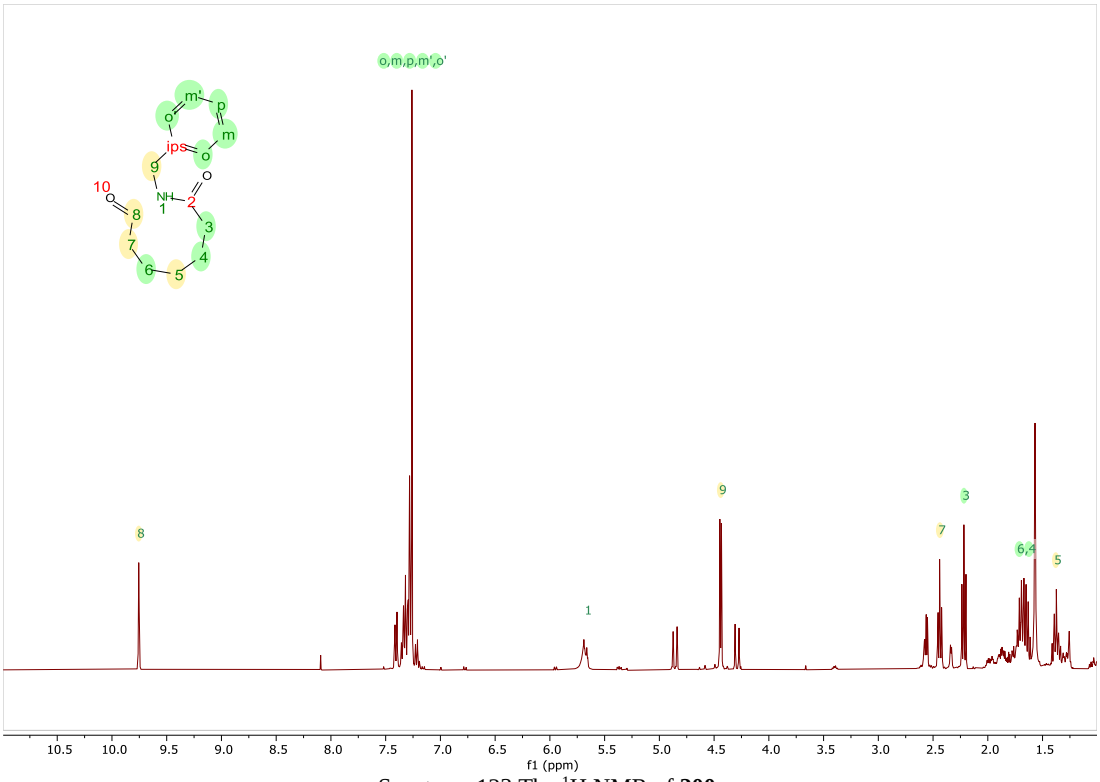
Spectrum 120 The ^{1}H NMR of **193**.



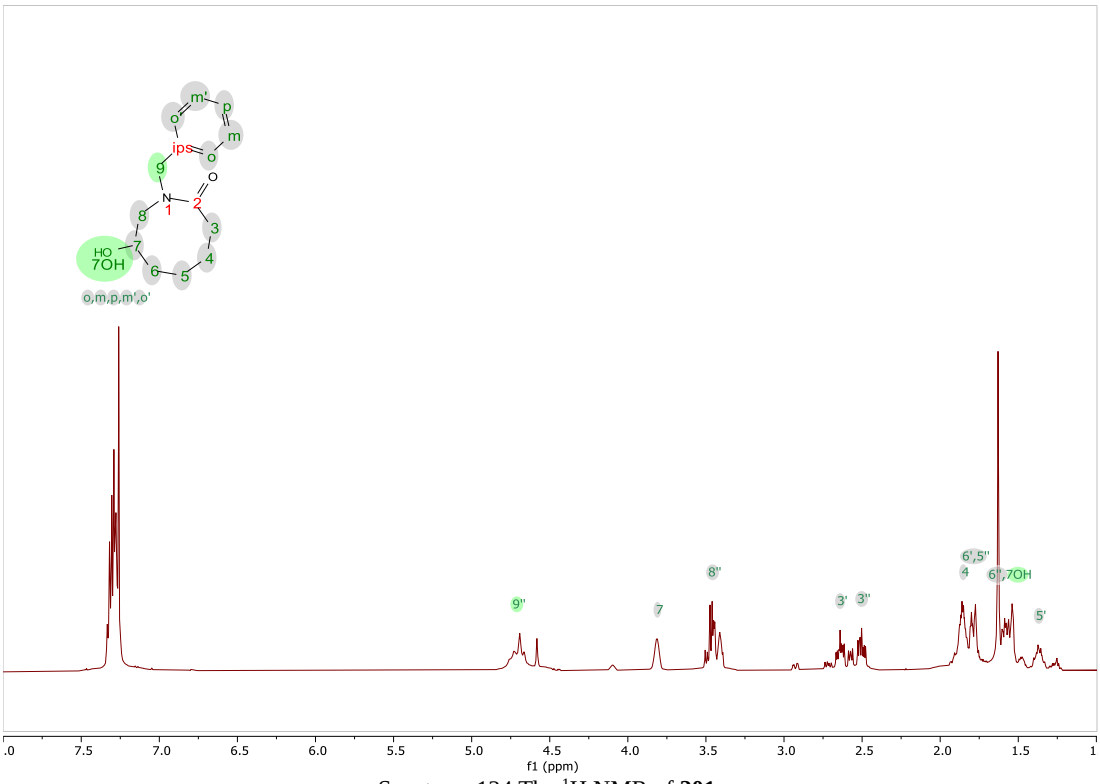
Spectrum 121 The ^{13}C NMR of **193**.



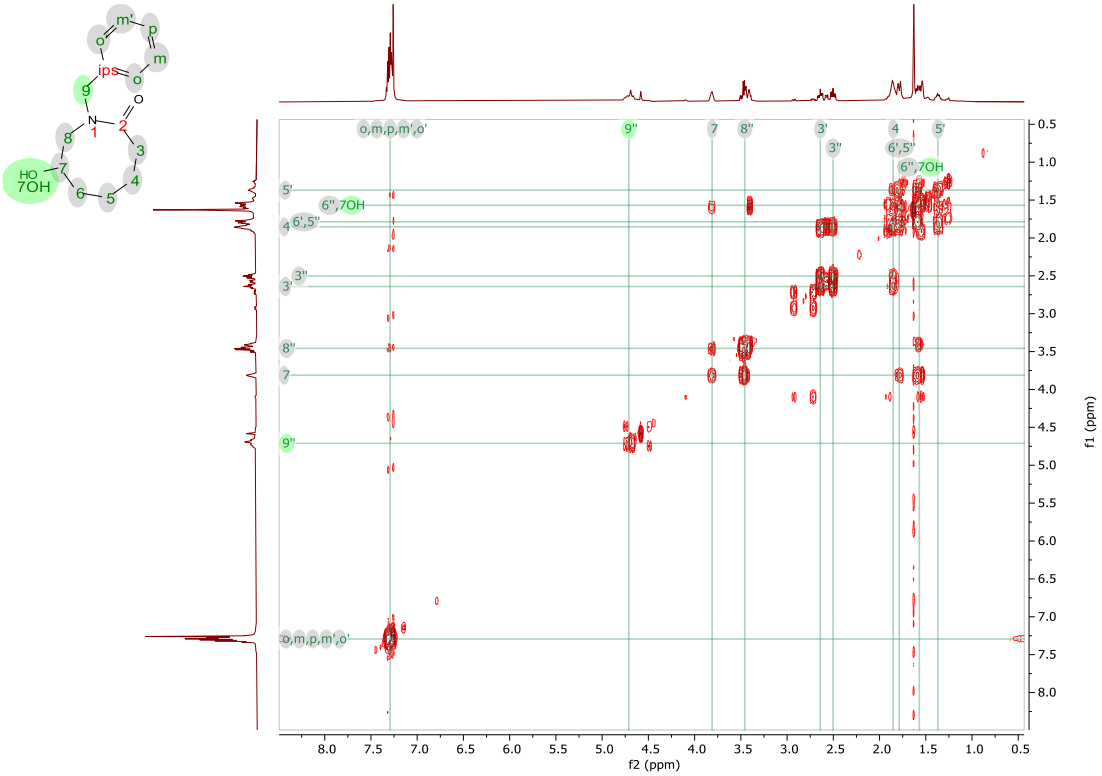
Spectrum 122 The ^{1}H NMR of **196**.



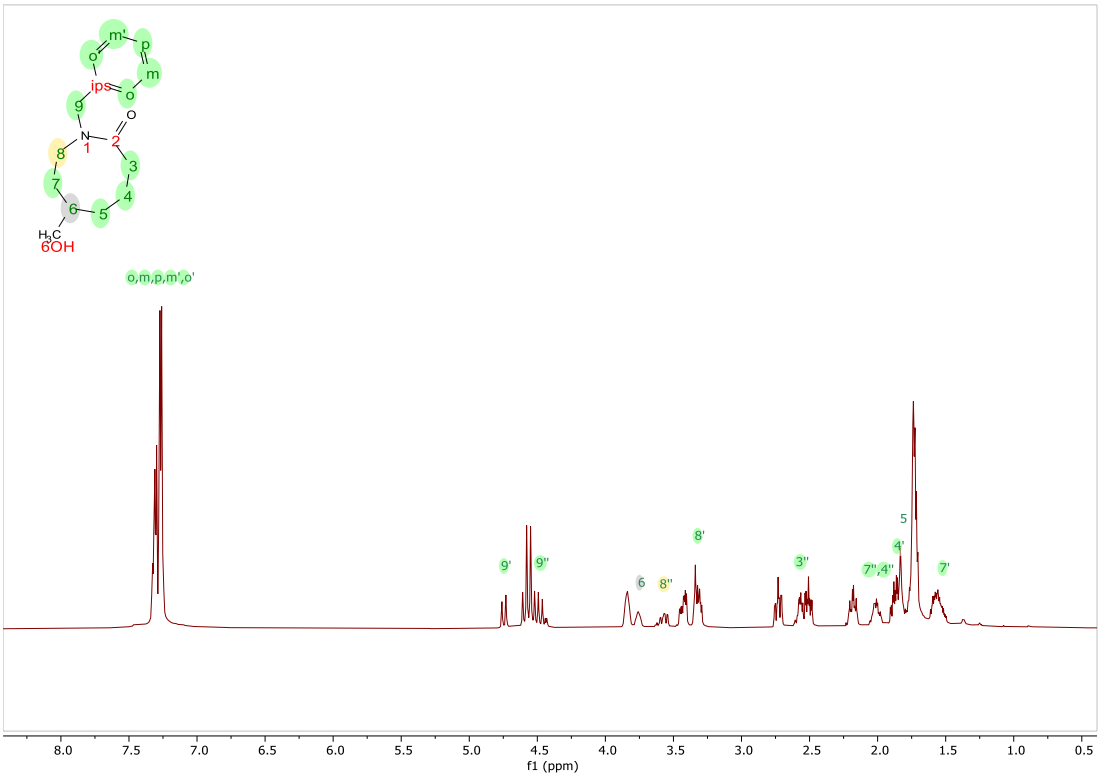
Spectrum 123 The ^{1}H NMR of **200**.



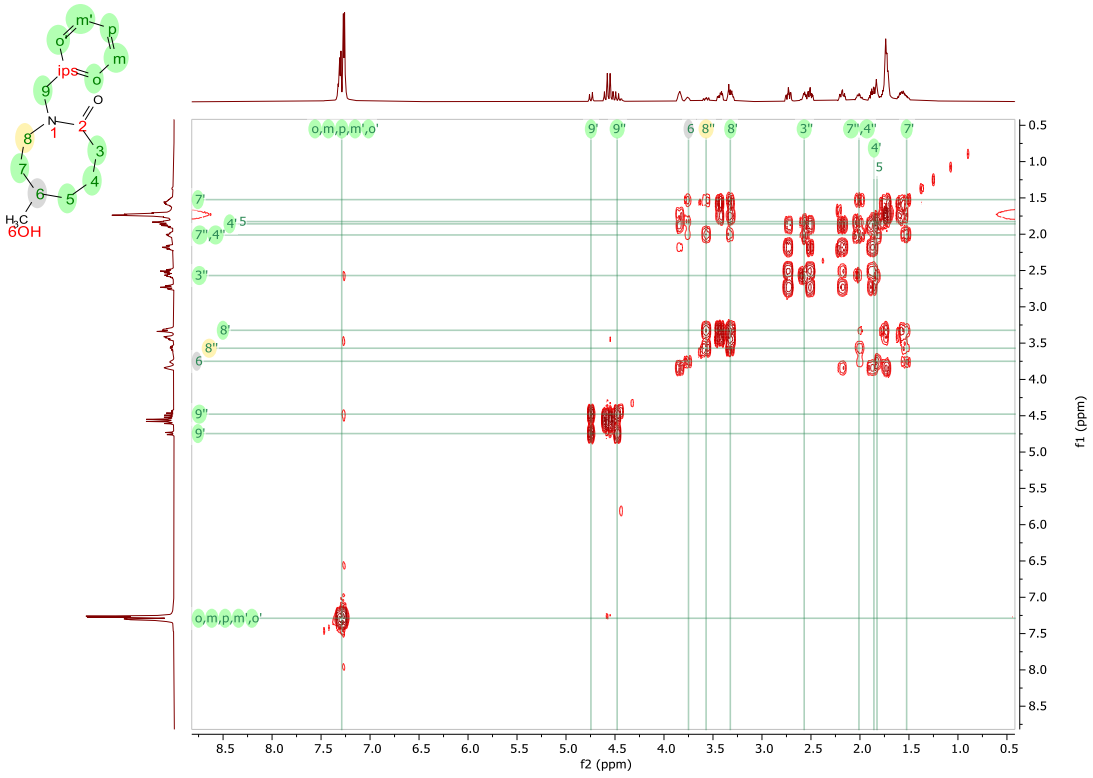
Spectrum 124 The ^{1}H NMR of **201**.



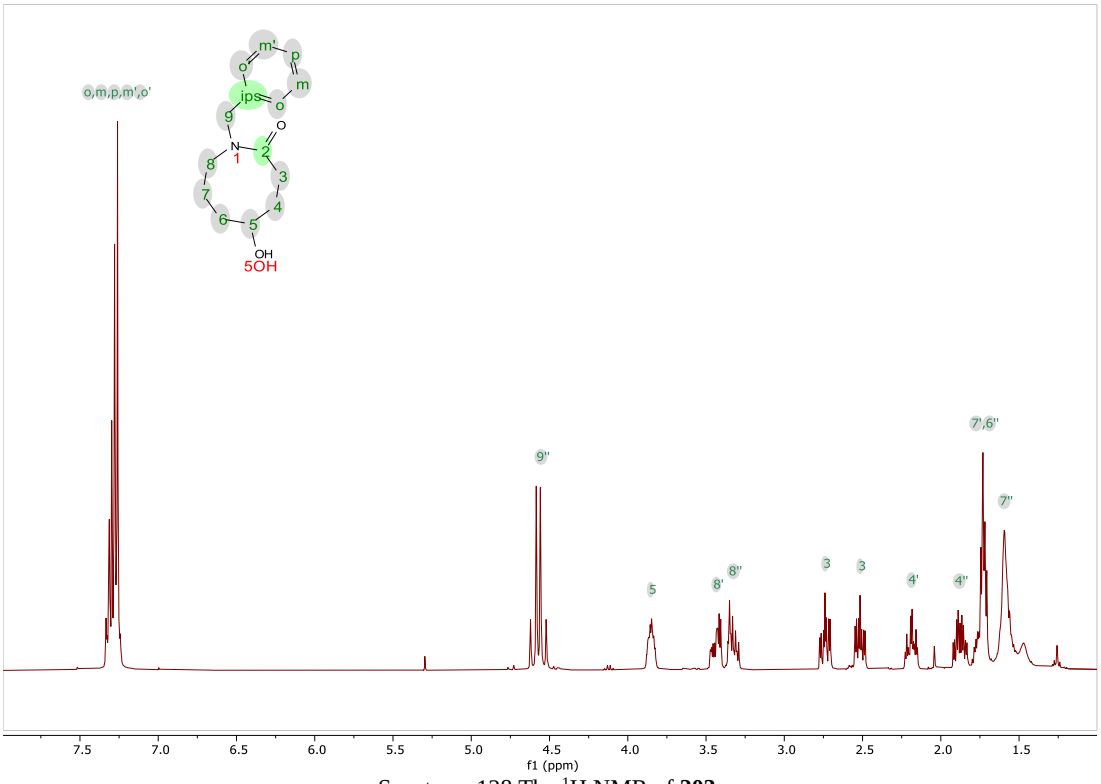
Spectrum 125 The COSY NMR of **201**.



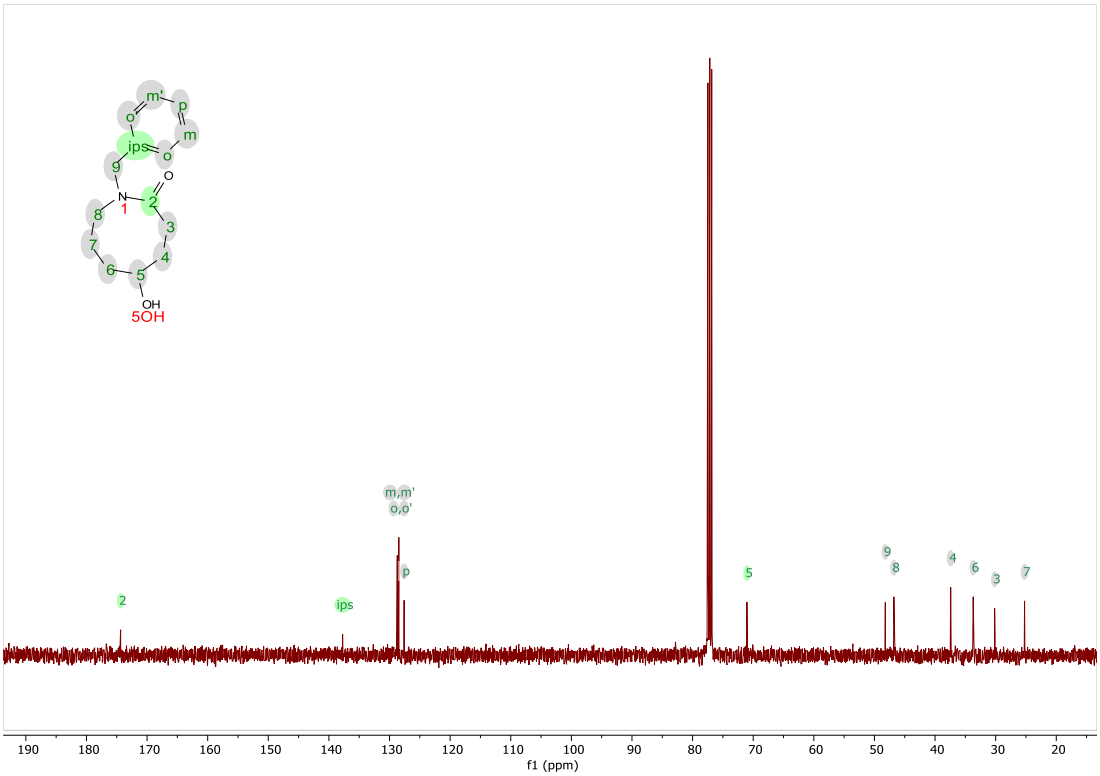
Spectrum 126 The ^{1}H NMR of **202**.



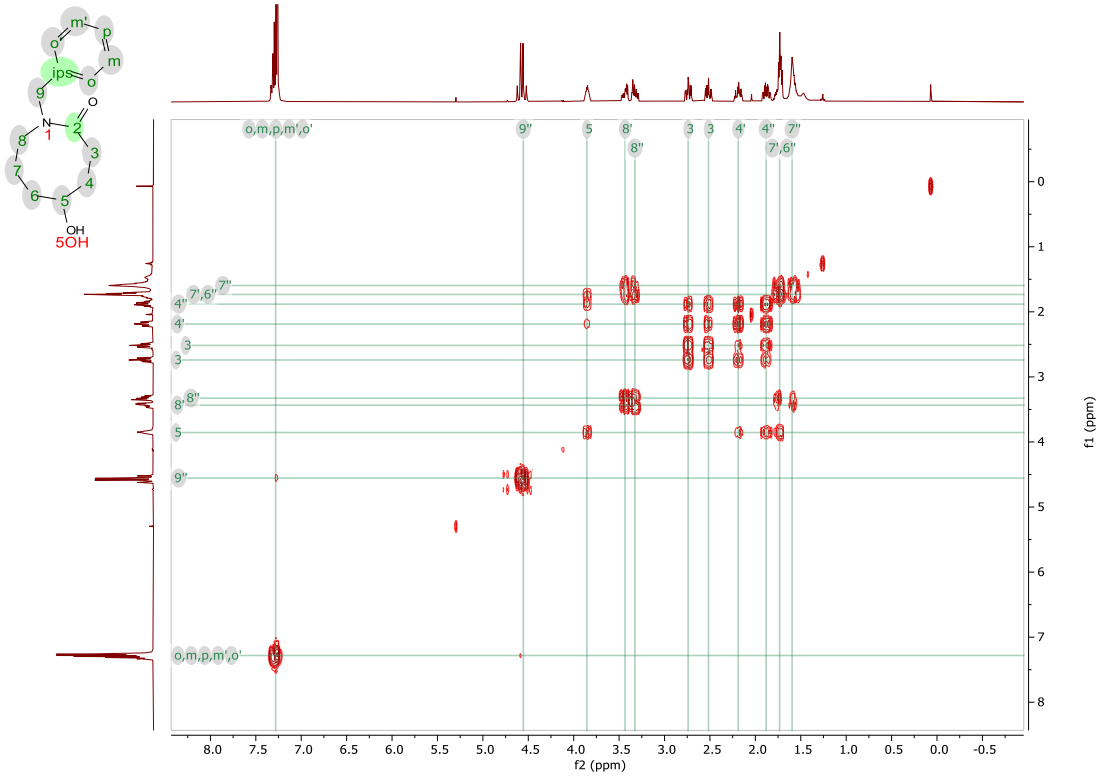
Spectrum 127 The COSY NMR of **202**.



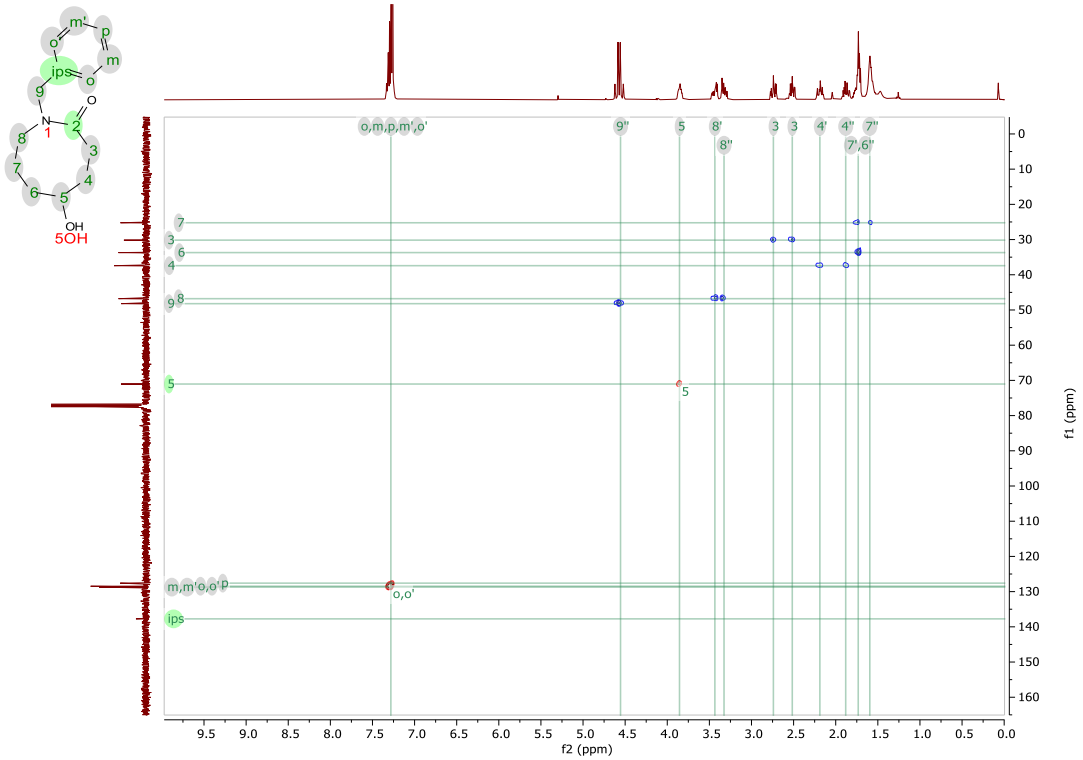
Spectrum 128 The ^{1}H NMR of **203**.



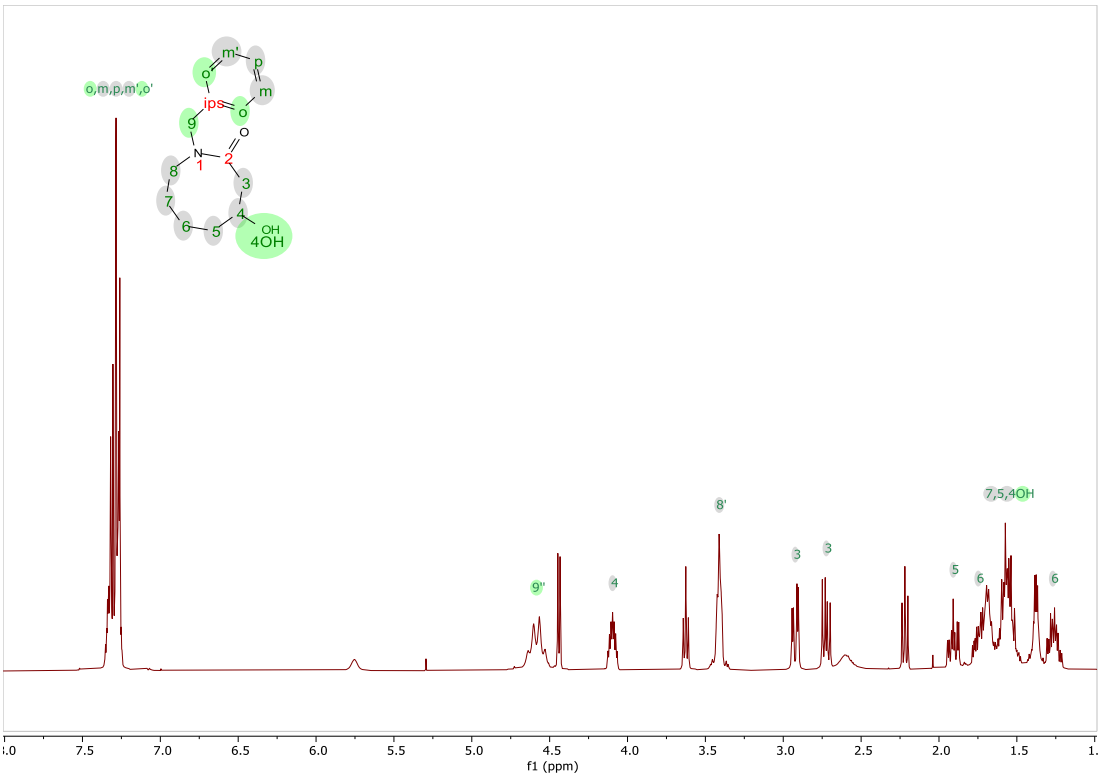
Spectrum 129 The ^{13}C NMR of **203**.



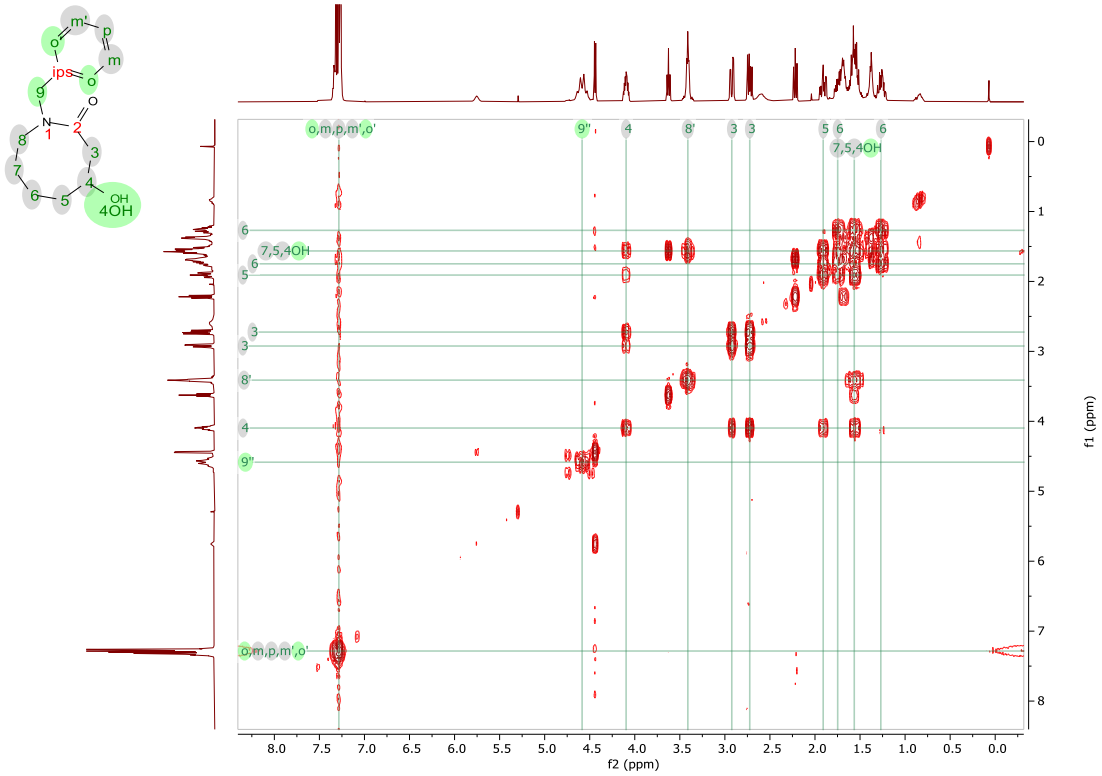
Spectrum 130 The COSY NMR of **203**.



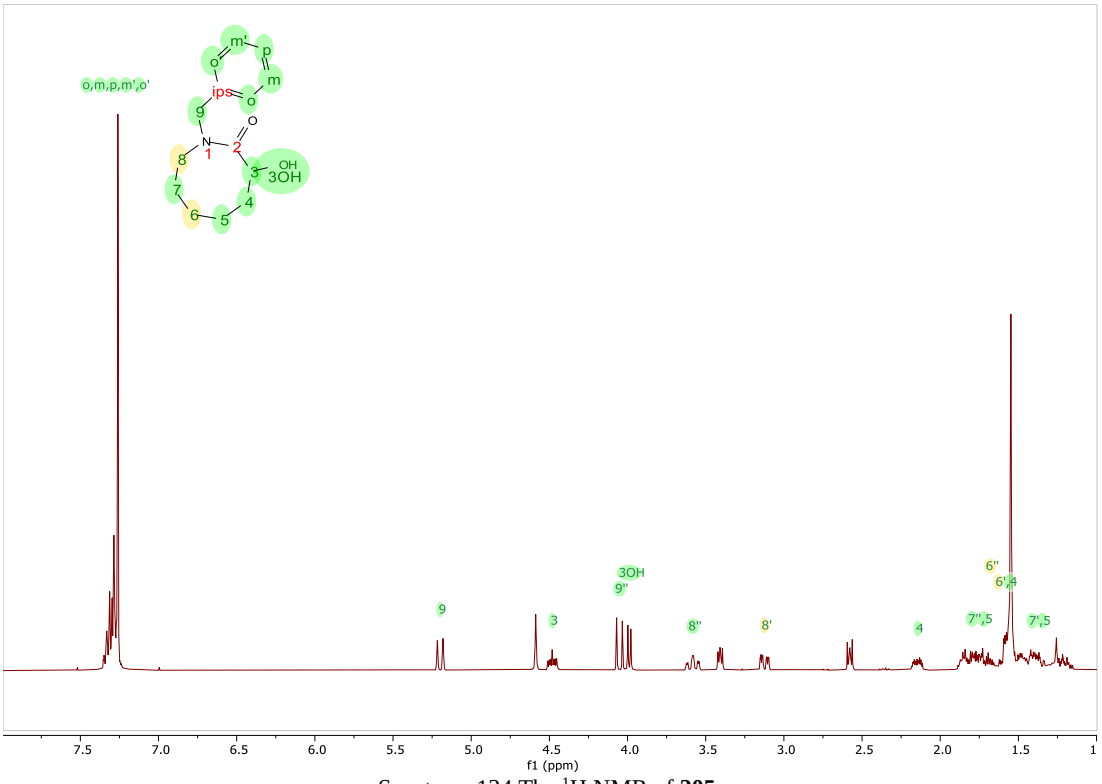
Spectrum 131 The HSQC NMR of **203**.



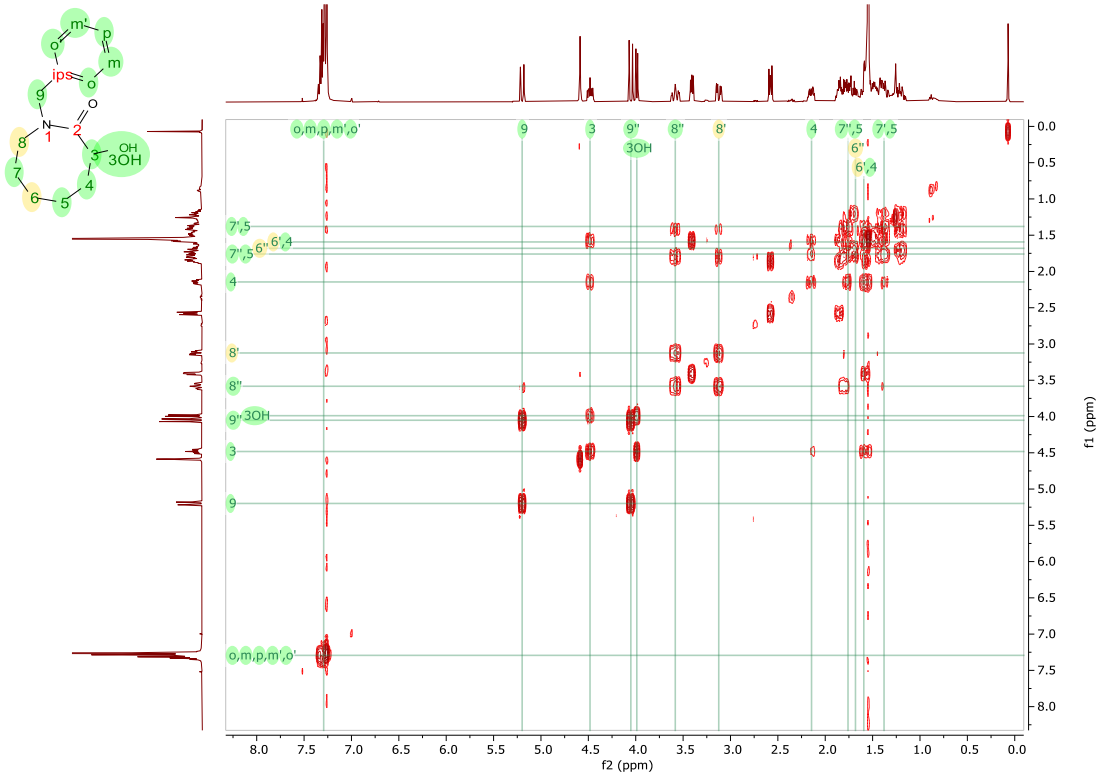
Spectrum 132 The ^{1}H NMR of **204**.



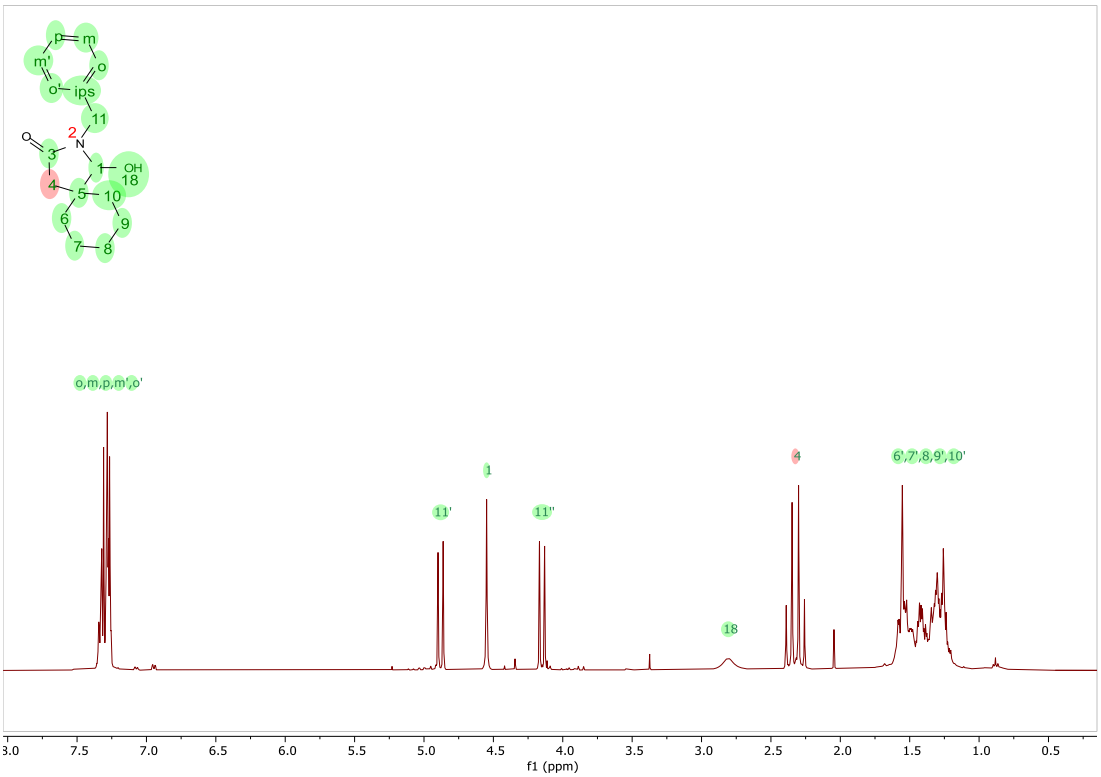
Spectrum 133 The COSY NMR of **204**.



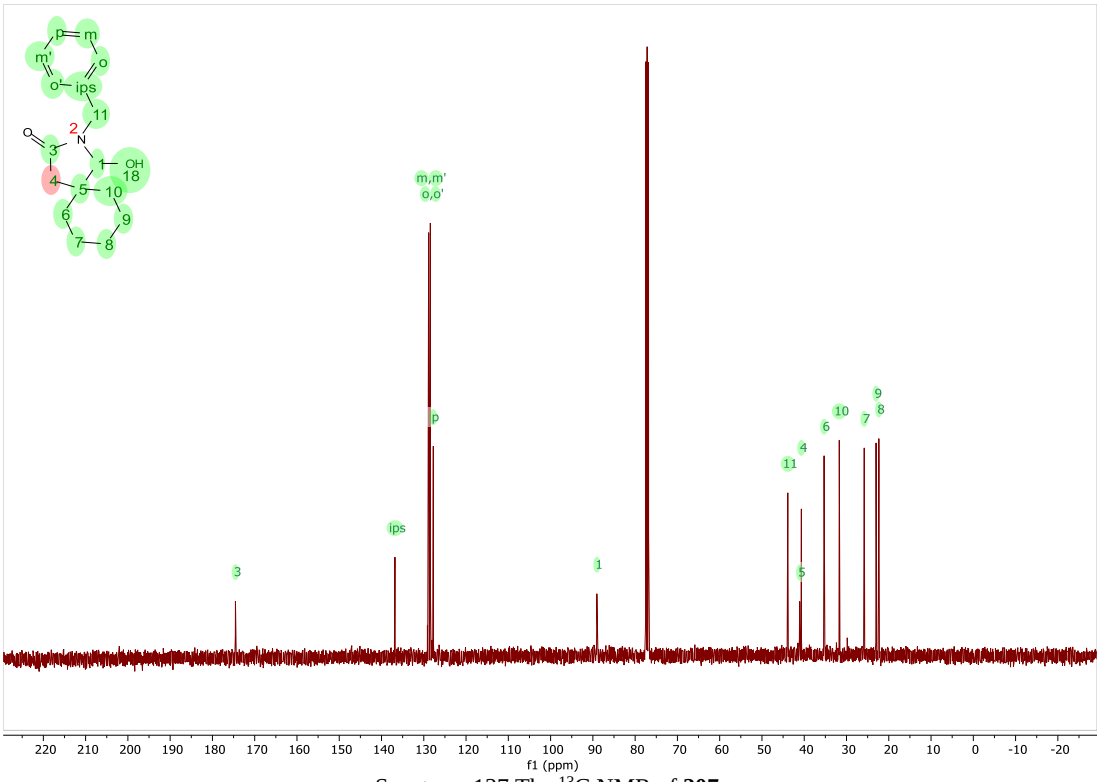
Spectrum 134 The ^{1}H NMR of **205**.



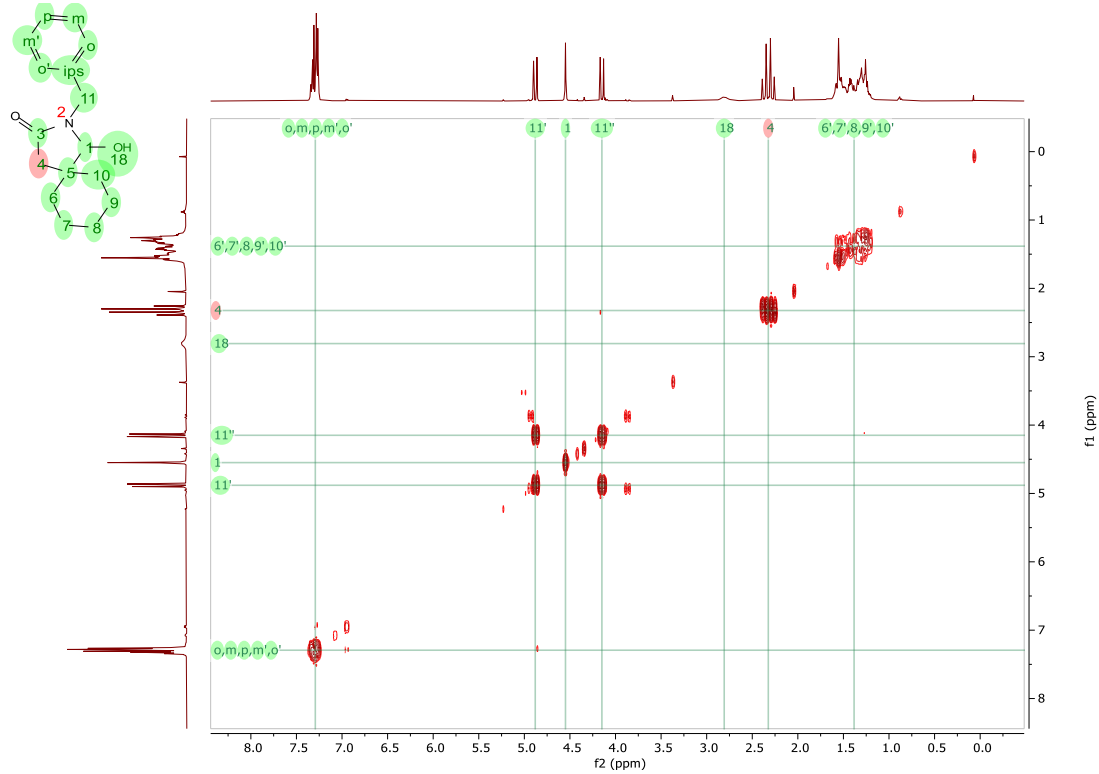
Spectrum 135 The COSY NMR of **205**.



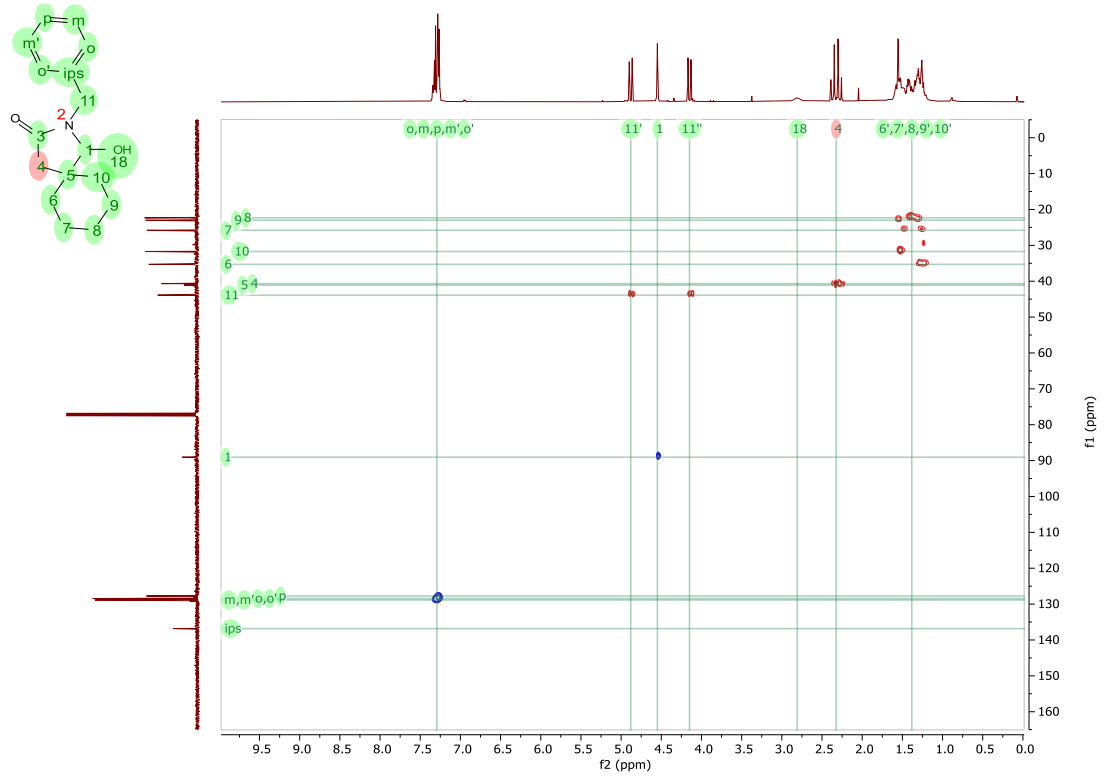
Spectrum 136 The ^{1}H NMR of **207**.



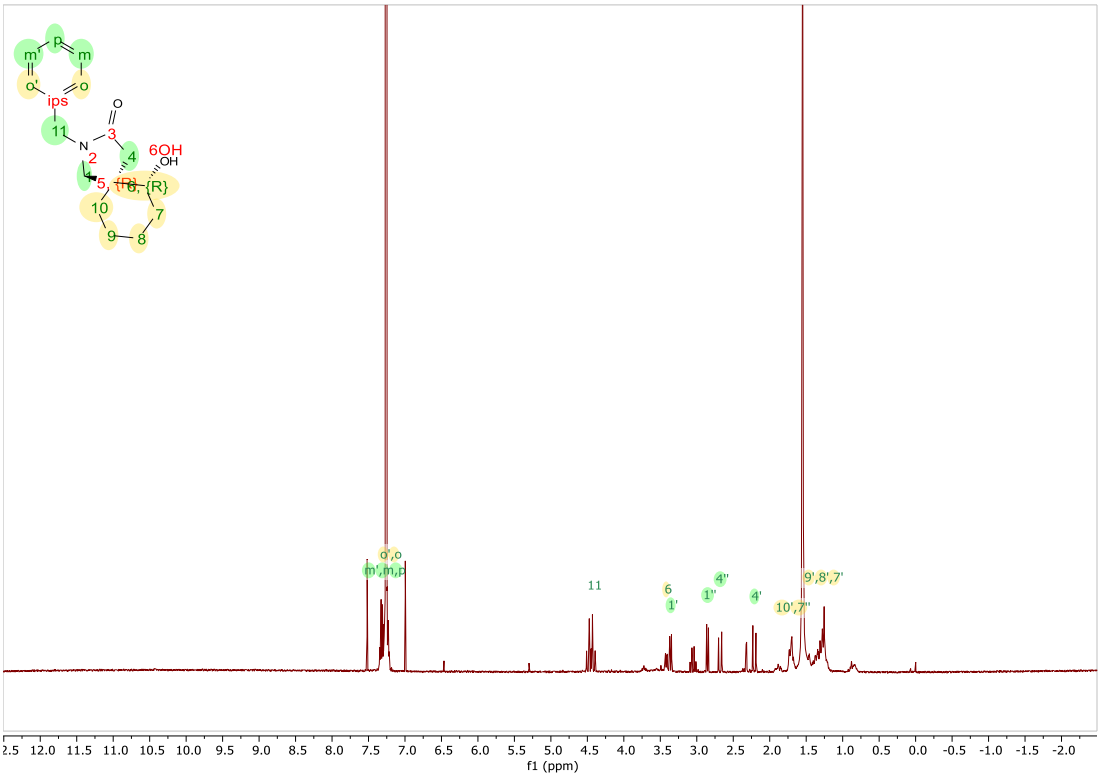
Spectrum 137 The ^{13}C NMR of **207**.



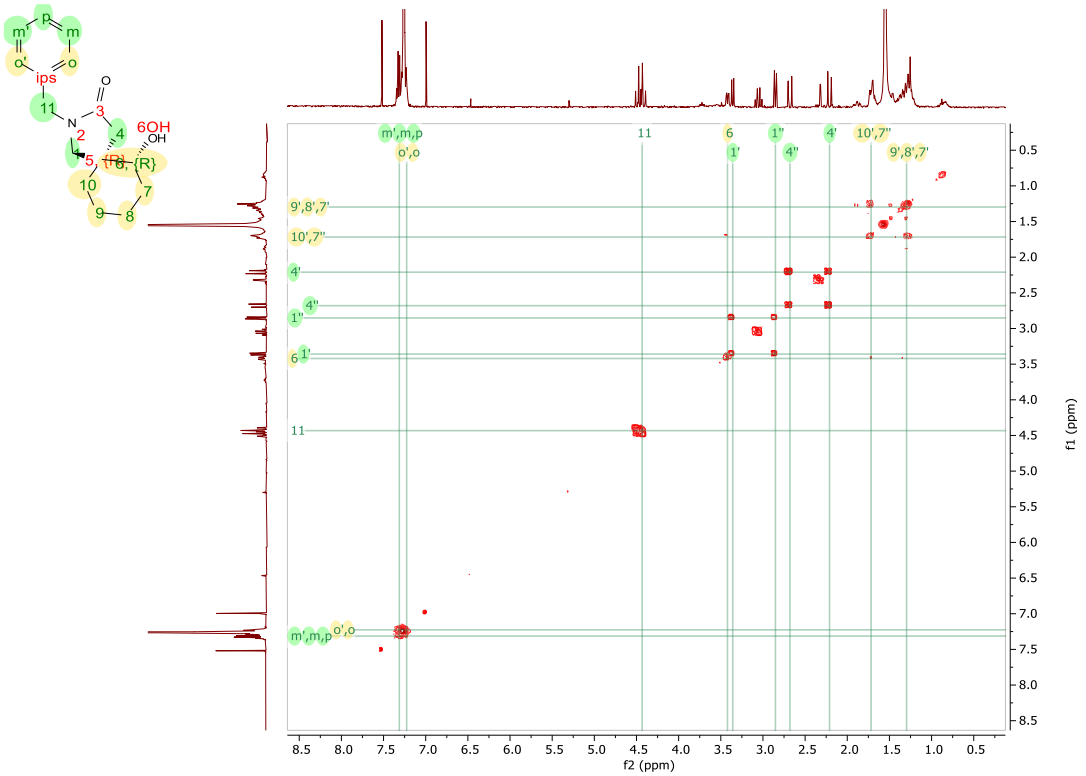
Spectrum 138 The COSY NMR of **207**.



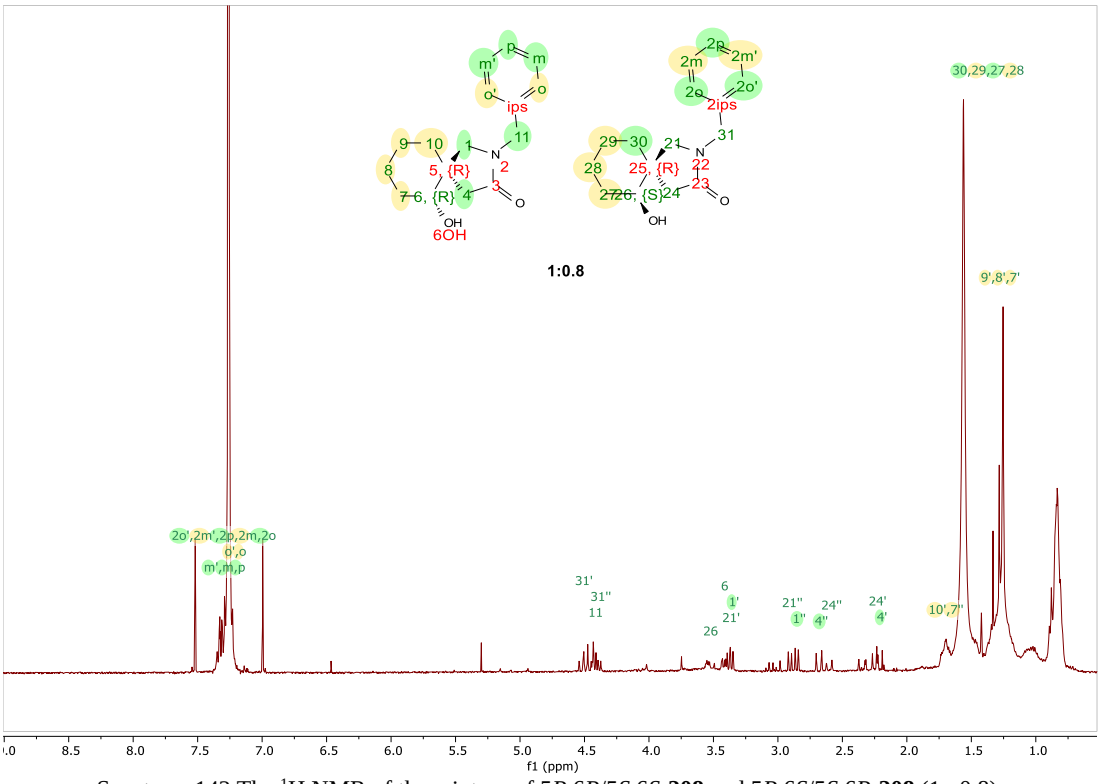
Spectrum 139 The HSQC NMR of **207**.



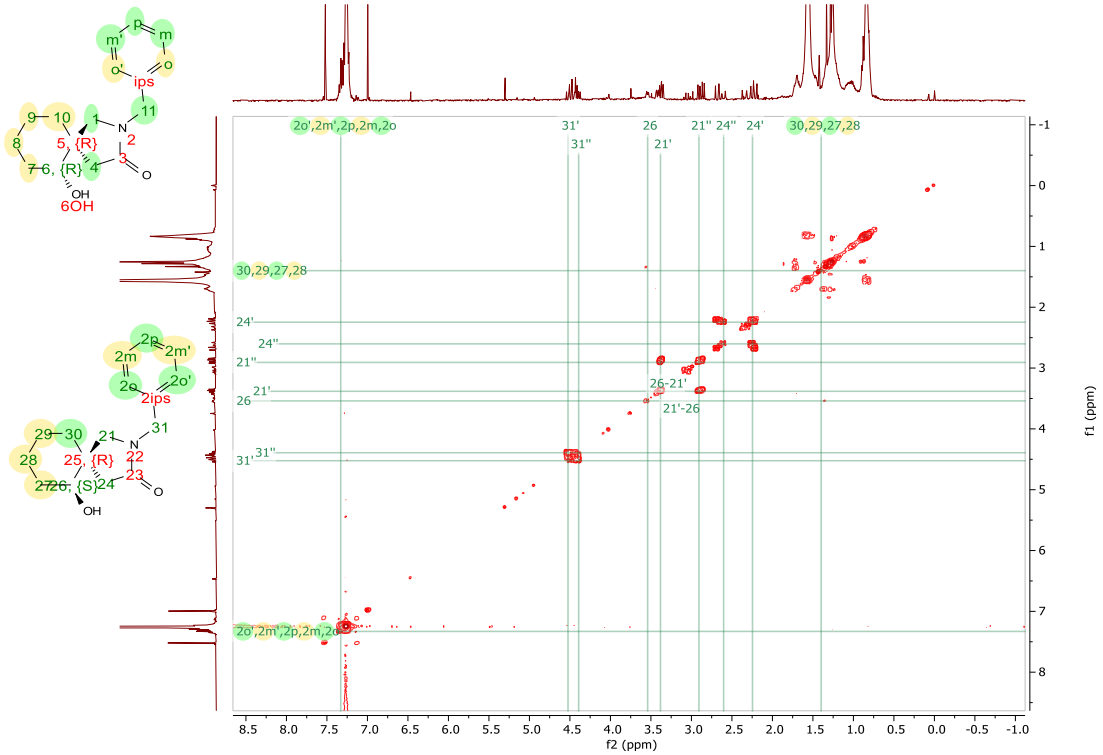
Spectrum 140 The ^{1}H NMR of 5*R*,6*R*/5*S*,6*S*-**208**.



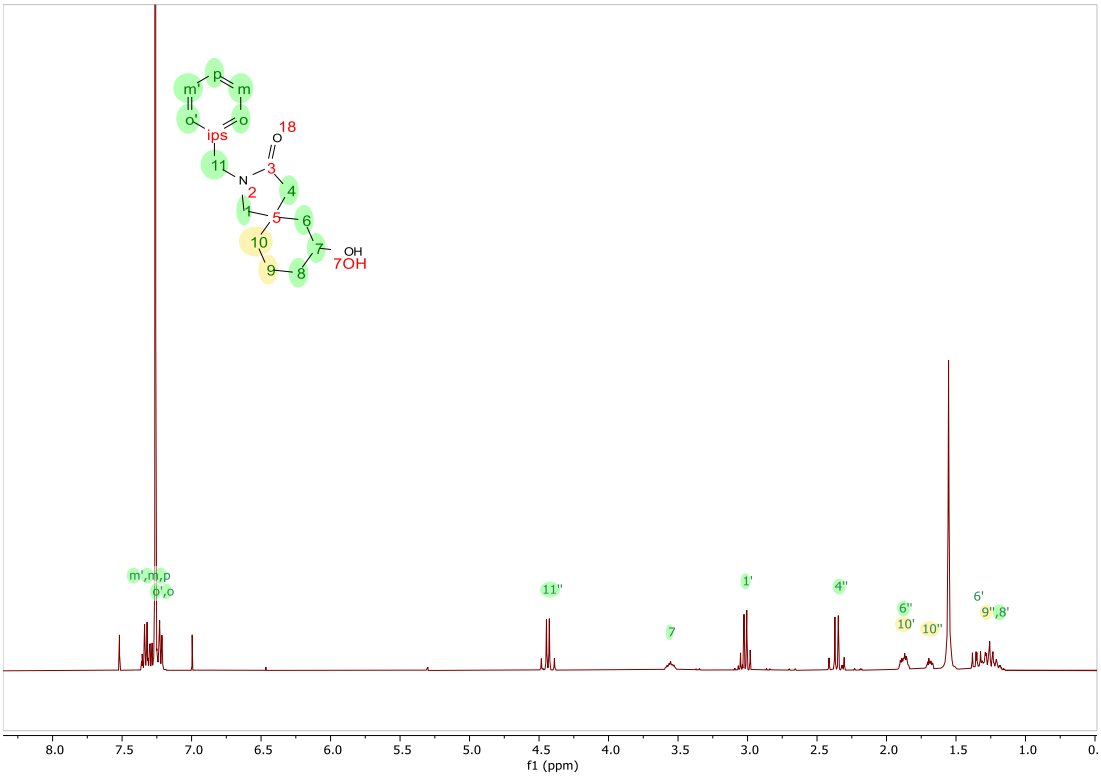
Spectrum 141 The COSY NMR of 5*R*,6*R*/5*S*,6*S*-**208**.



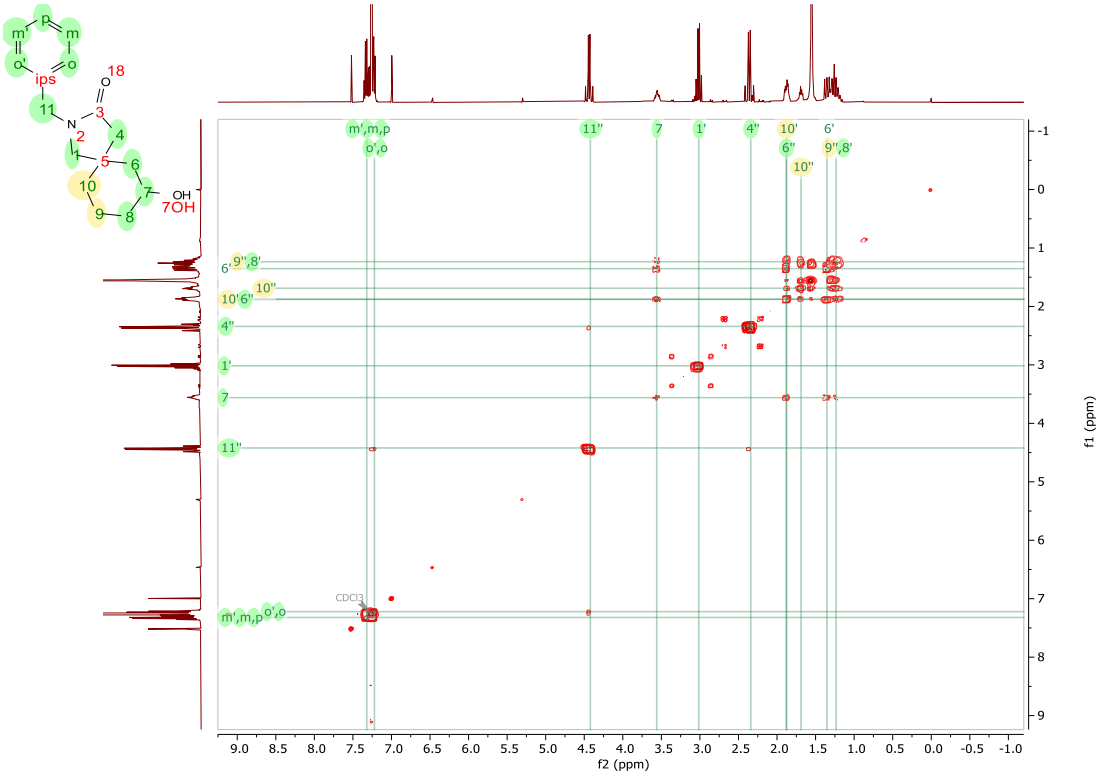
Spectrum 142 The ^{1}H NMR of the mixture of 5*R*,6*R*/5*S*,6*S*-**208** and 5*R*,6*S*/5*S*,6*R*-**208** (1 : 0.8).



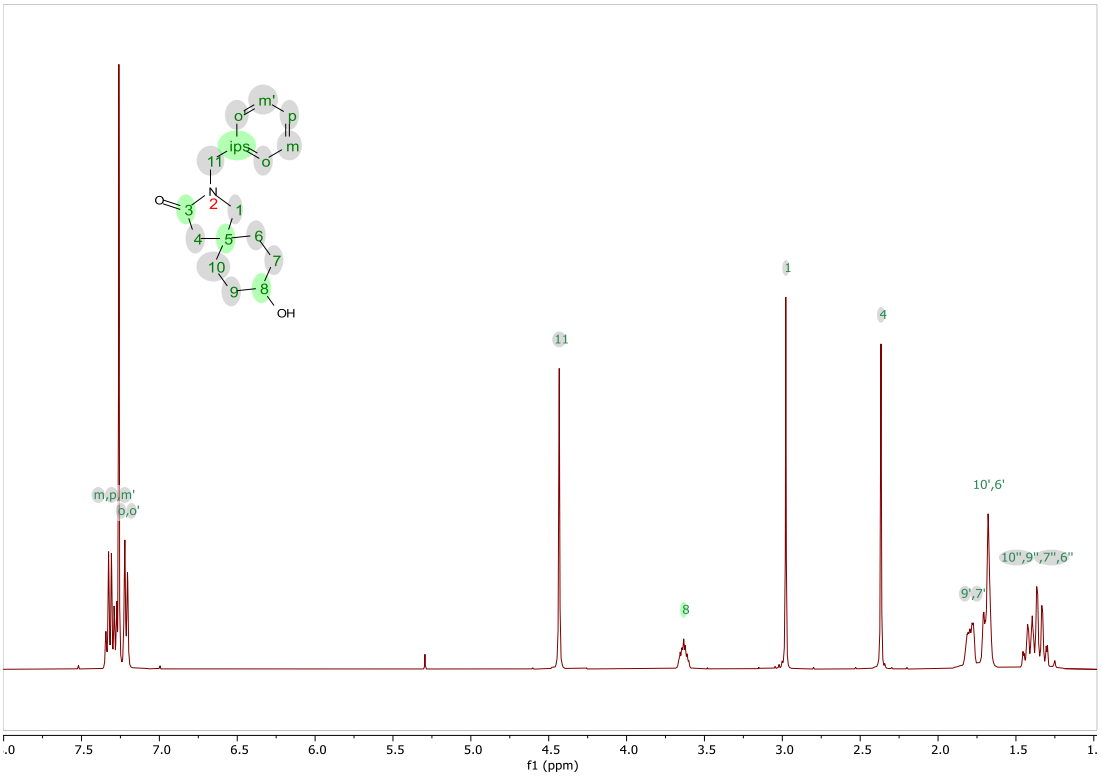
Spectrum 143 The COSY NMR of the mixture of 5*R*,6*R*/5*S*,6*S*-**208** and 5*R*,6*S*/5*S*,6*R*-**208** (1 : 0.8).



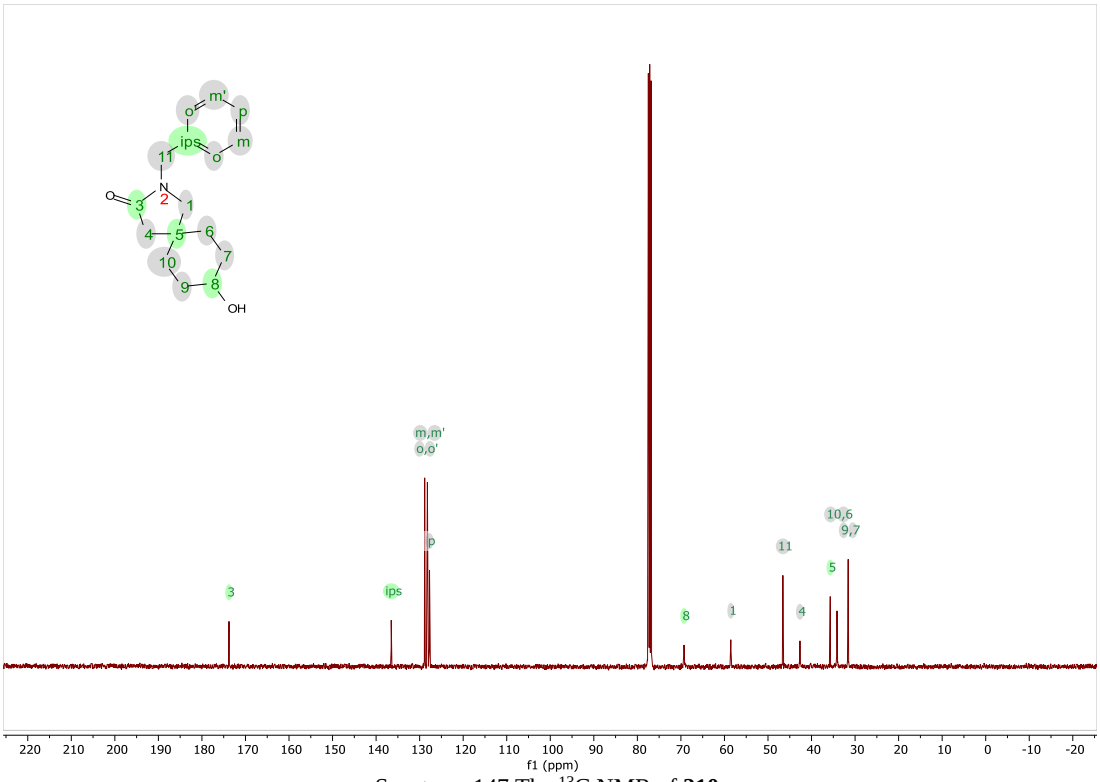
Spectrum 144 The ^{1}H NMR of **209**.



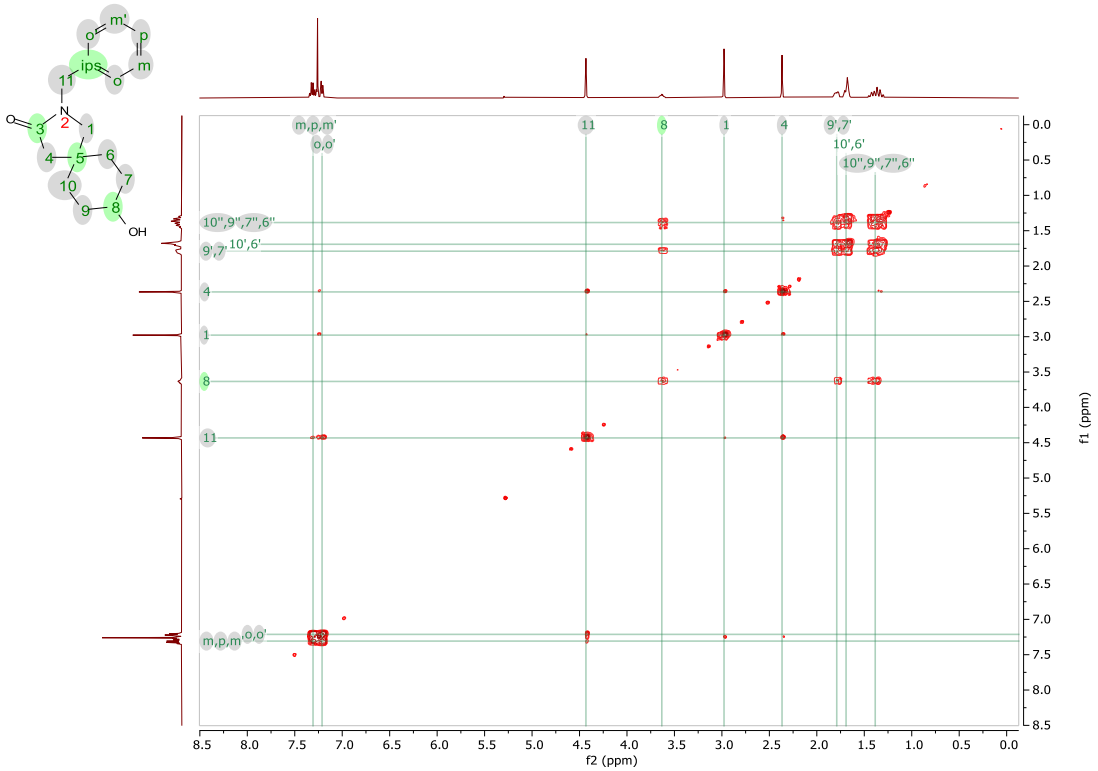
Spectrum 145 The COSY NMR of **209**.



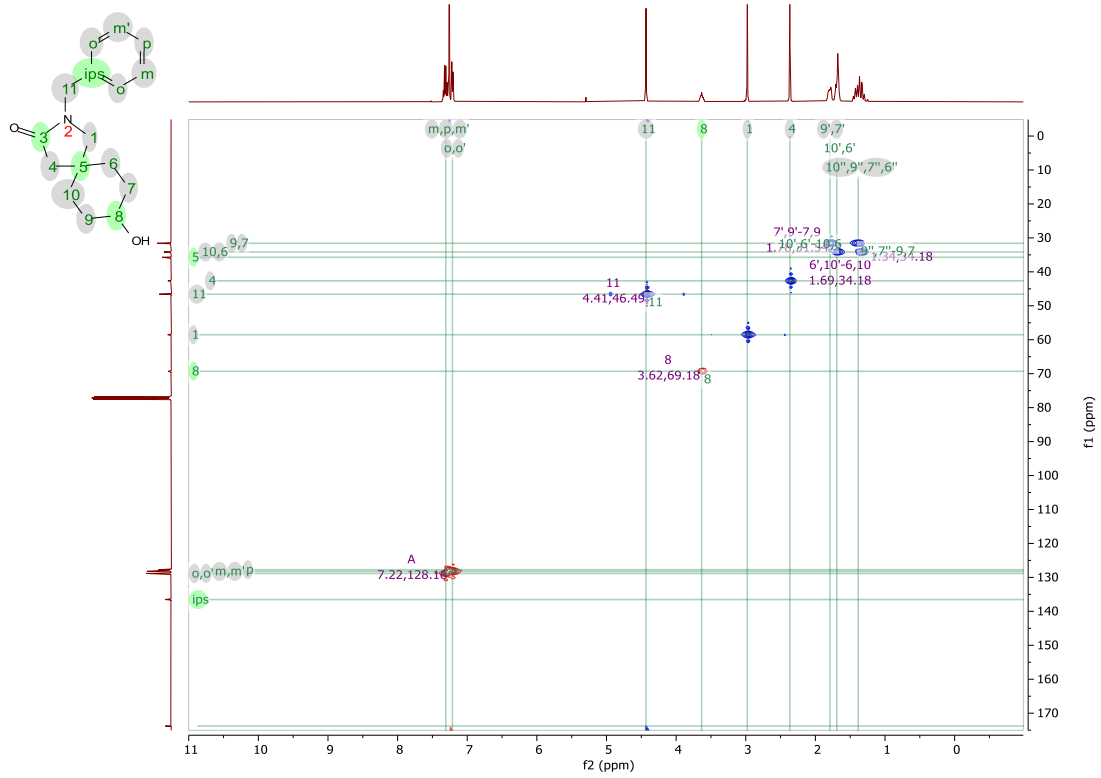
Spectrum 146 The ^{1}H NMR of **210**.



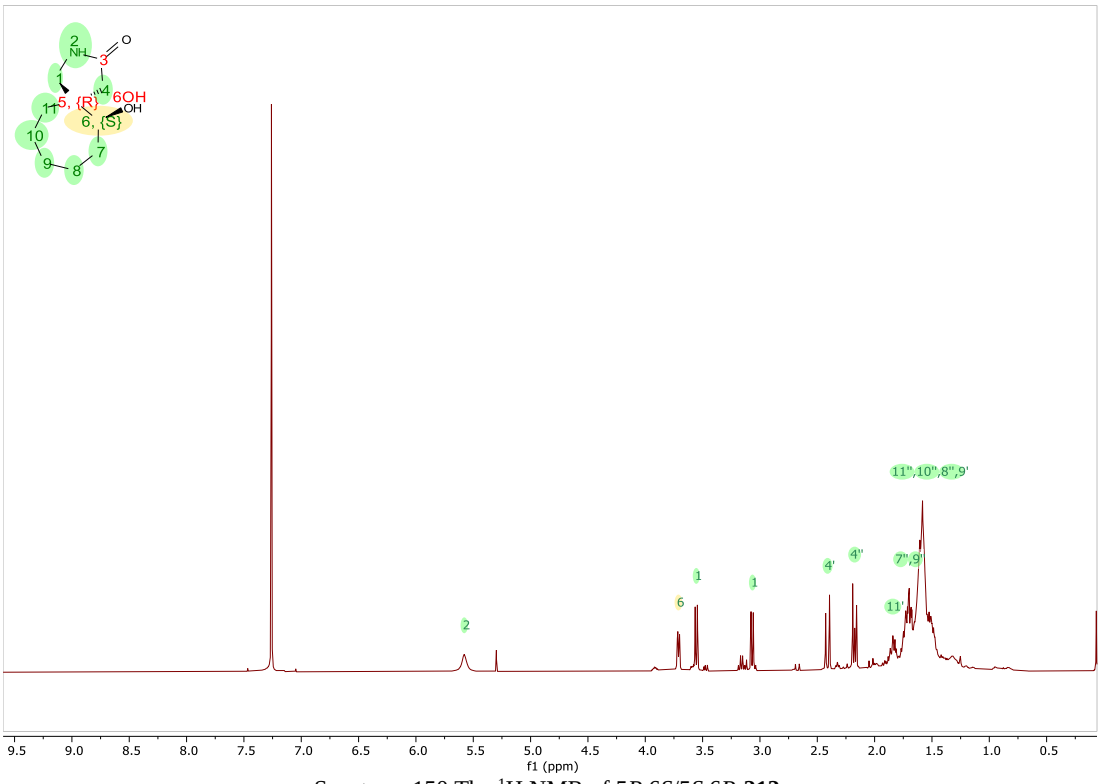
Spectrum 147 The ^{13}C NMR of **210**.



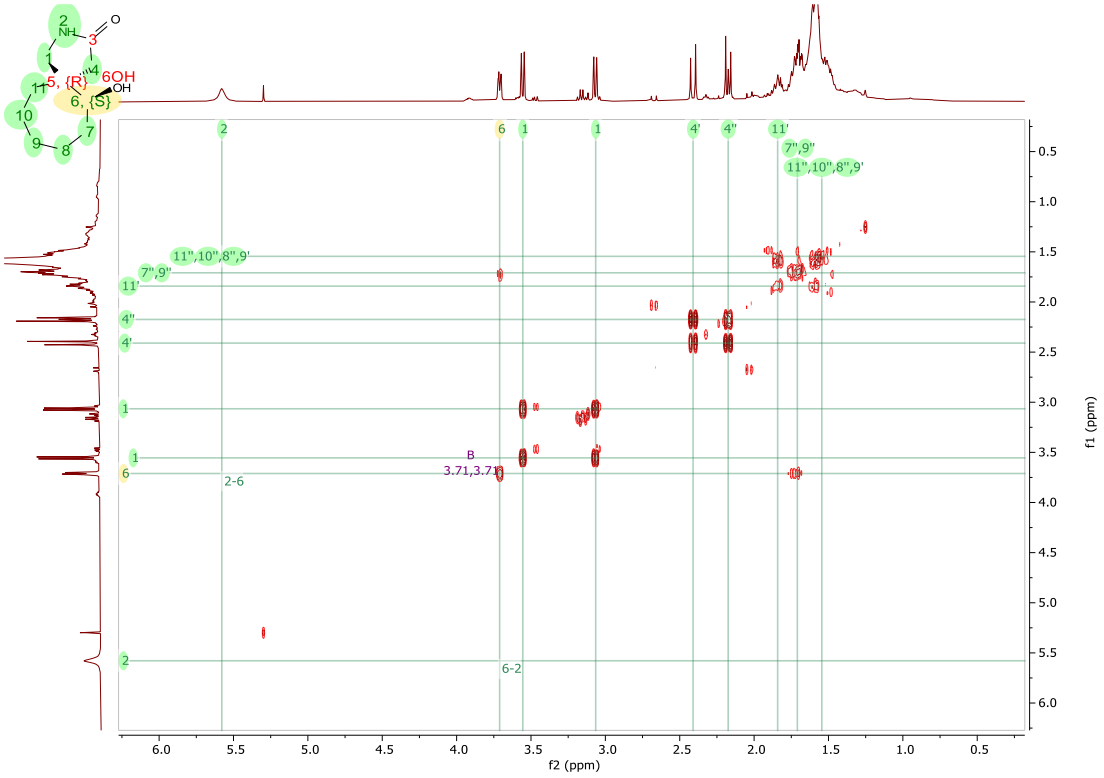
Spectrum 148 The COSY NMR of **210**.



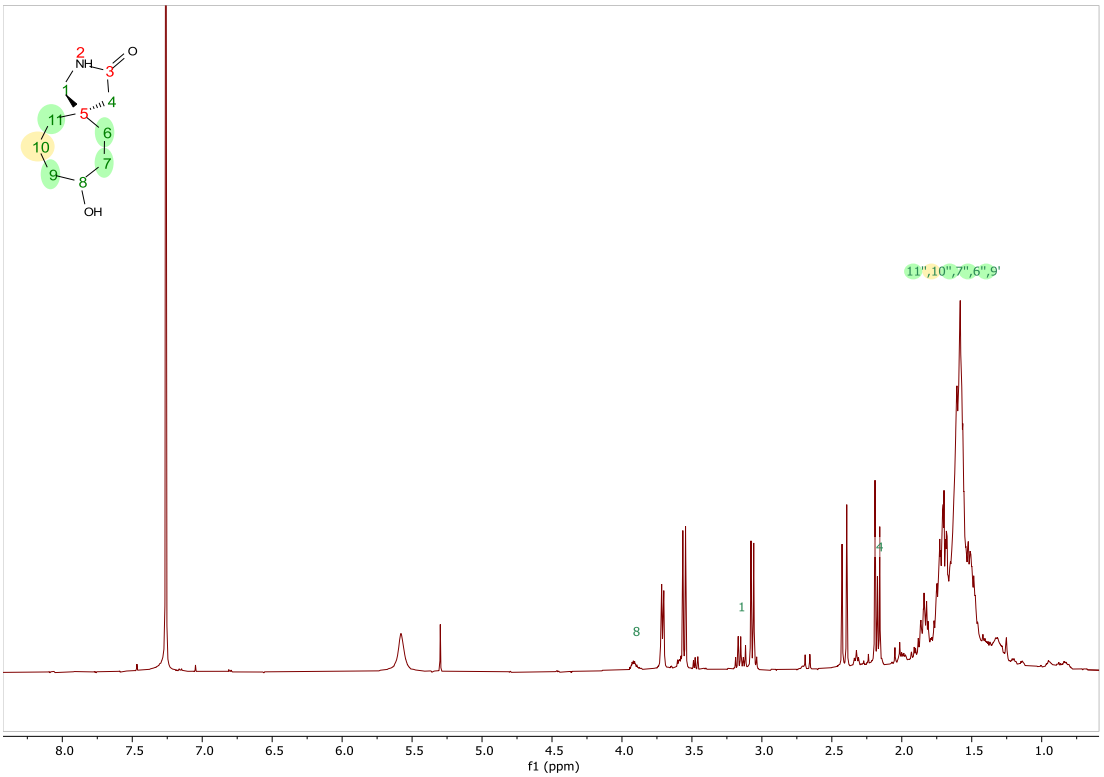
Spectrum 149 The HSQC NMR of **210**.



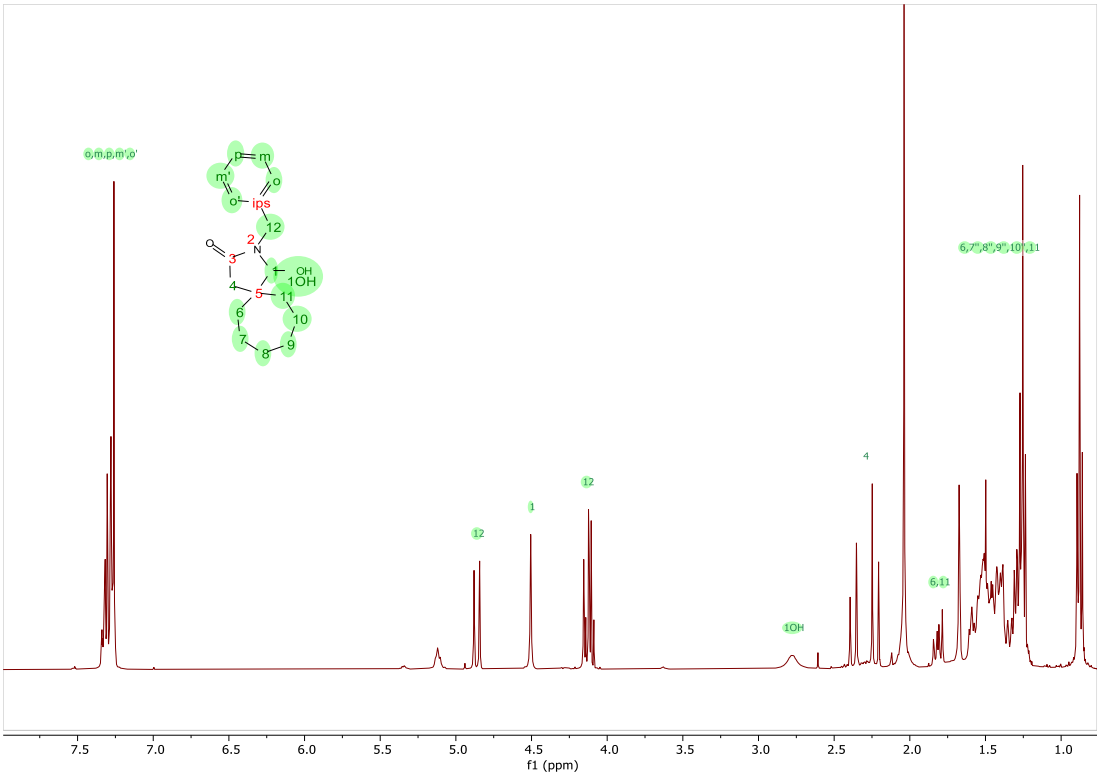
Spectrum 150 The ^{1}H NMR of 5*R*,6*S*/5*S*,6*R*-**212**.



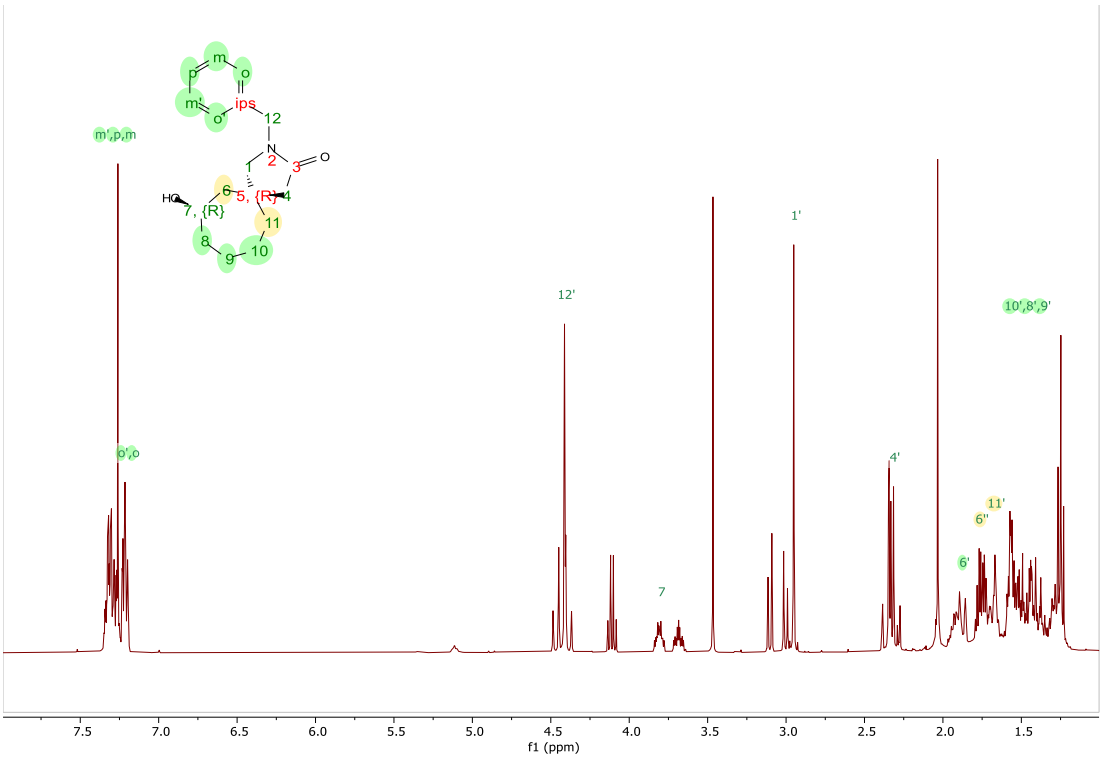
Spectrum 151 The COSY NMR of 5*R*,6*S*/5*S*,6*R*-**212**.



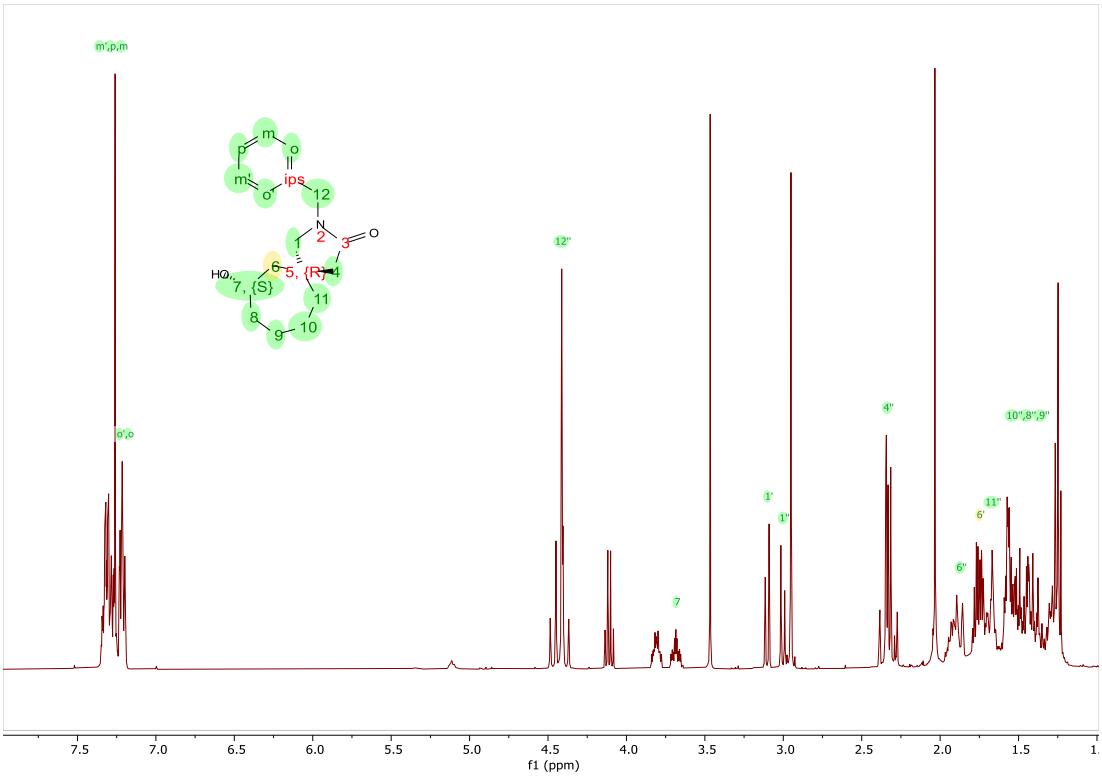
Spectrum 152 The ^{1}H NMR of **213**.



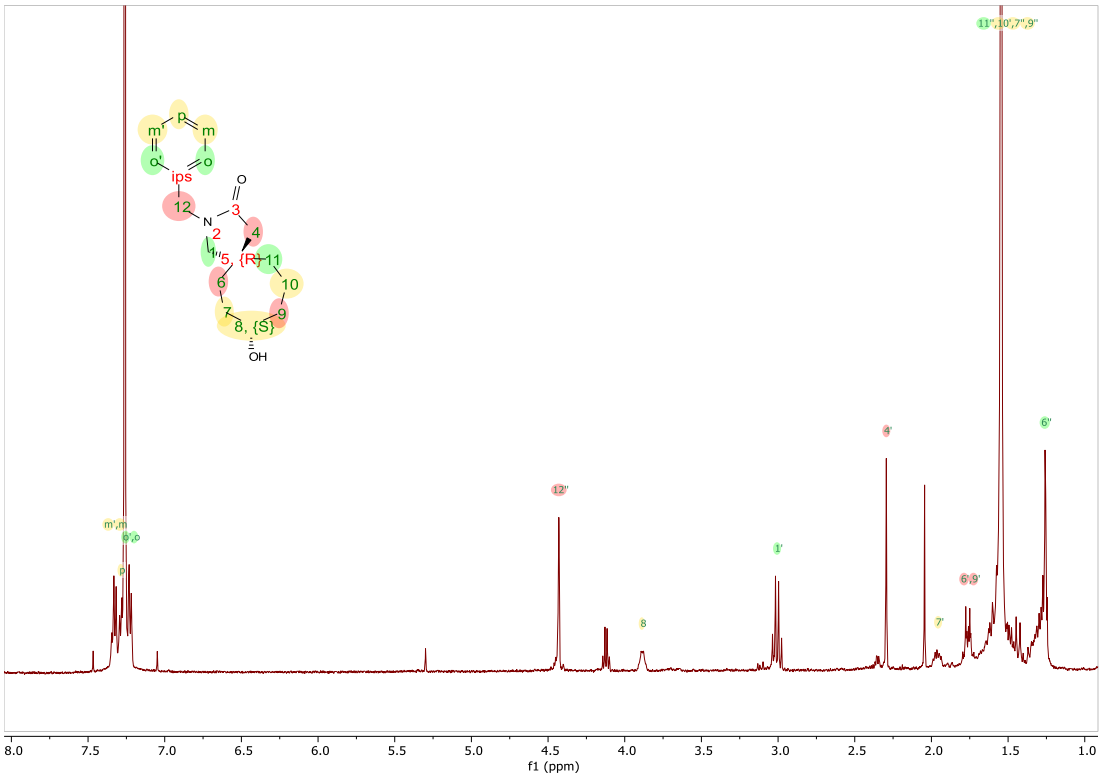
Spectrum 153 The ^{1}H NMR of **215**.



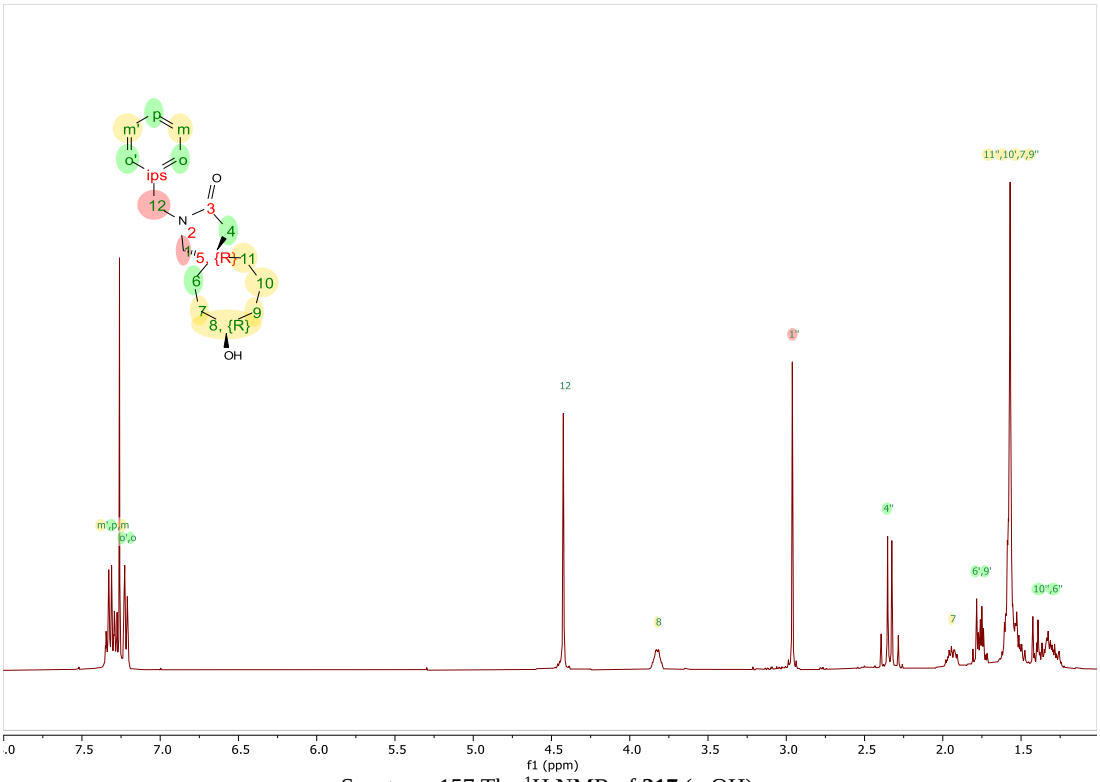
Spectrum 154 The ^{1}H NMR of **216** (b-OH).



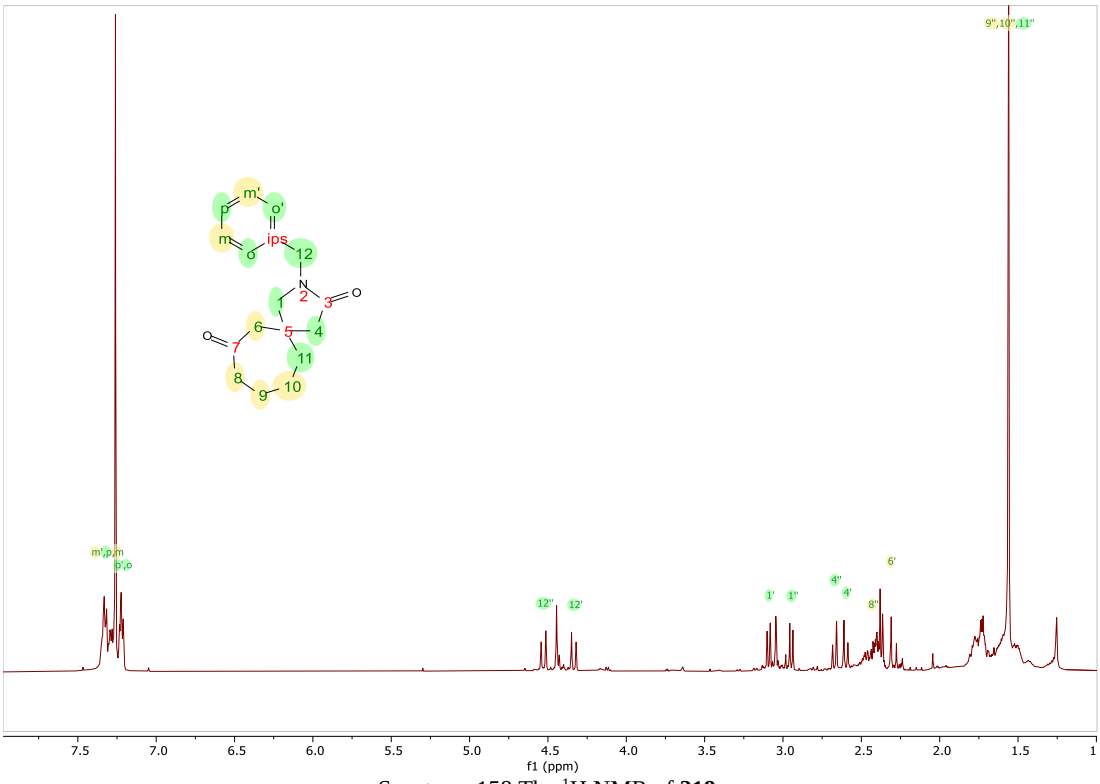
Spectrum 155 The ^{1}H NMR of **216** (b*-OH).



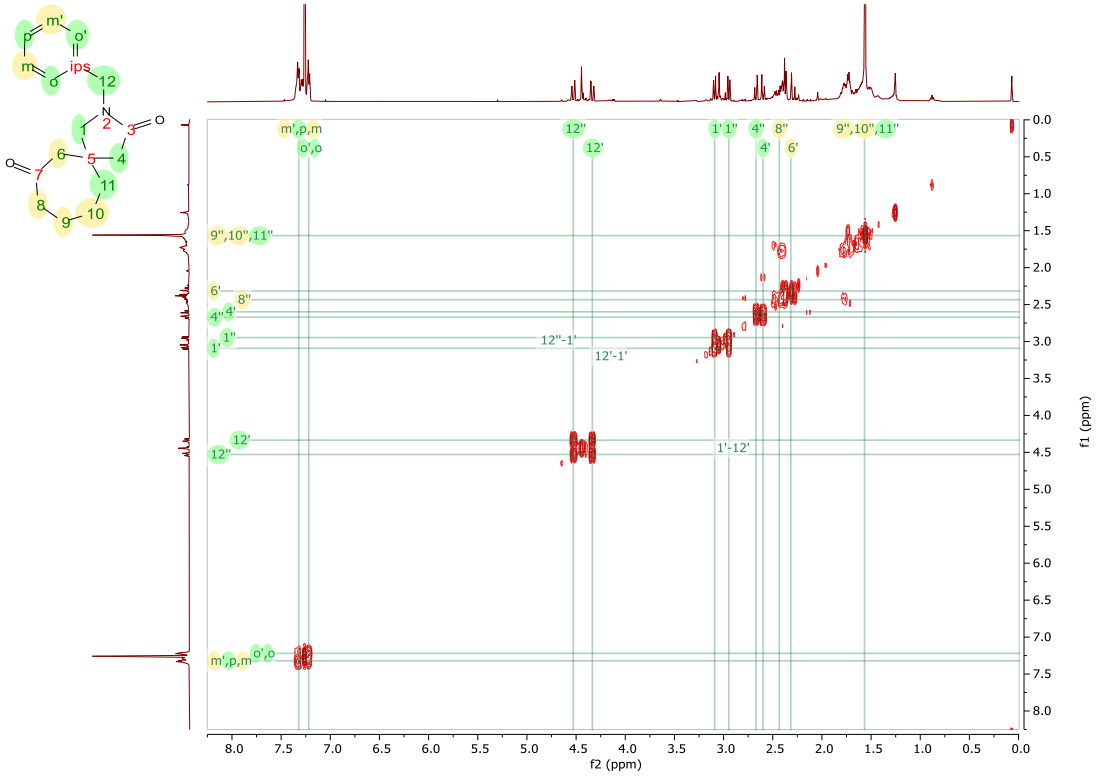
Spectrum 156 The ^{1}H NMR of **217** (c*-OH).



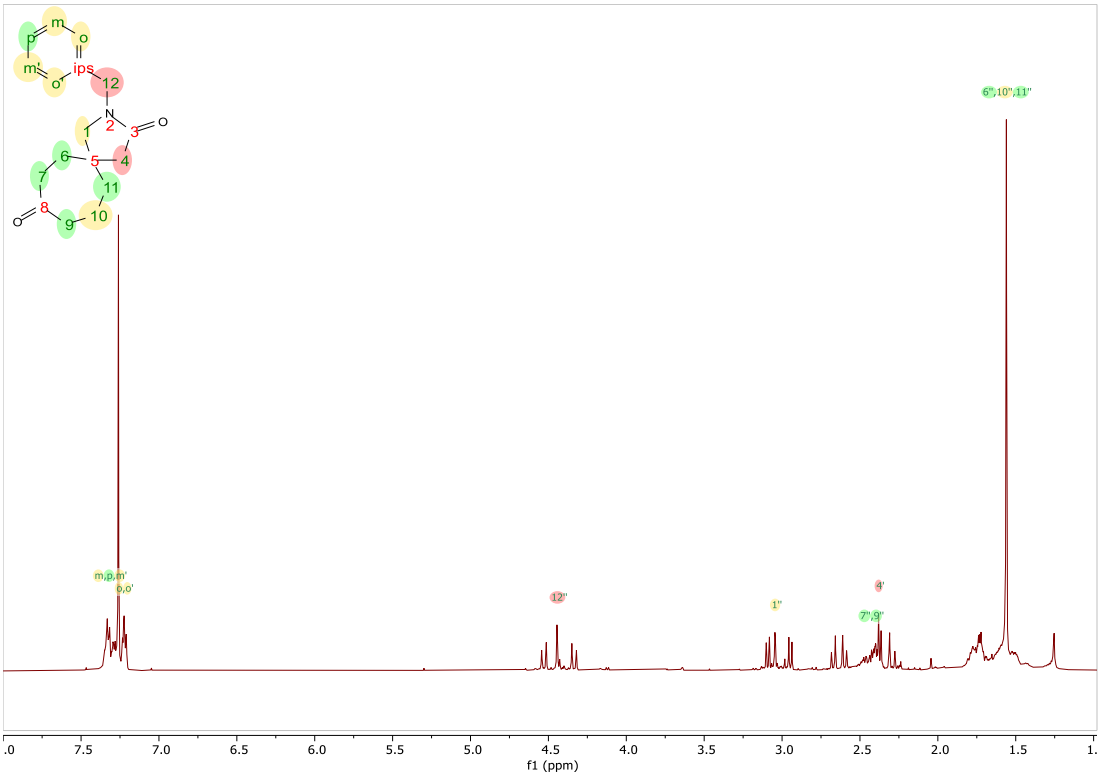
Spectrum 157 The ^{1}H NMR of **217** (c-OH).



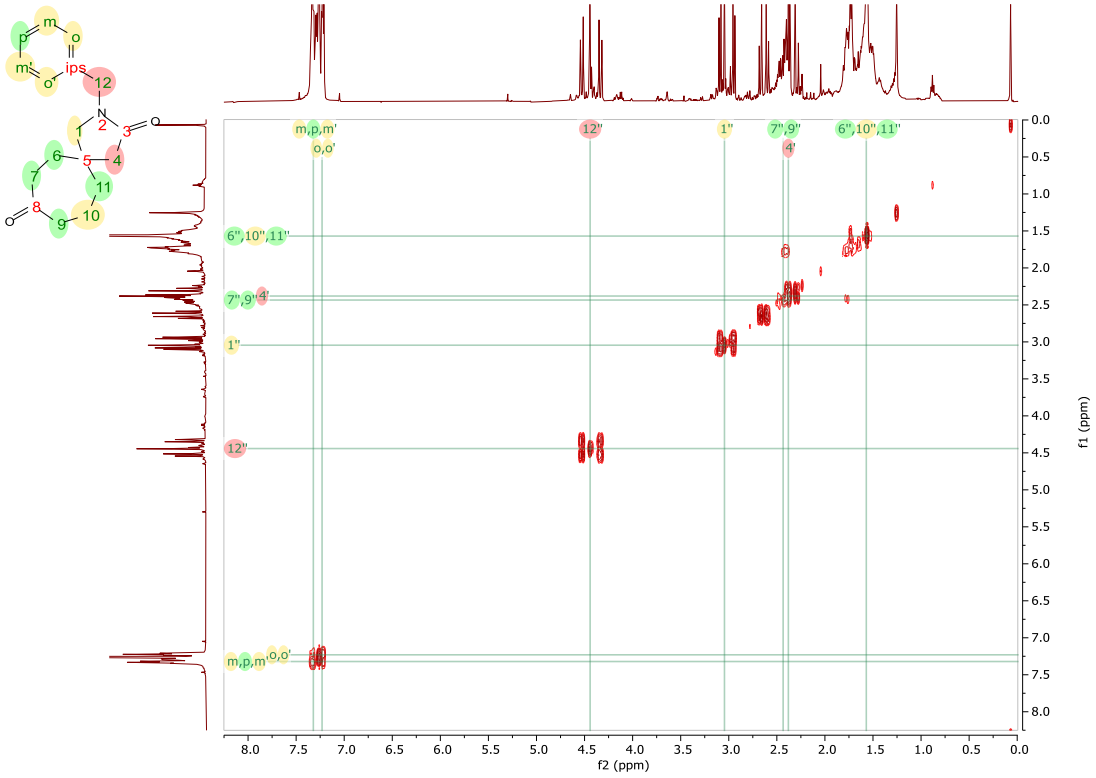
Spectrum 158 The ^{1}H NMR of **218**.



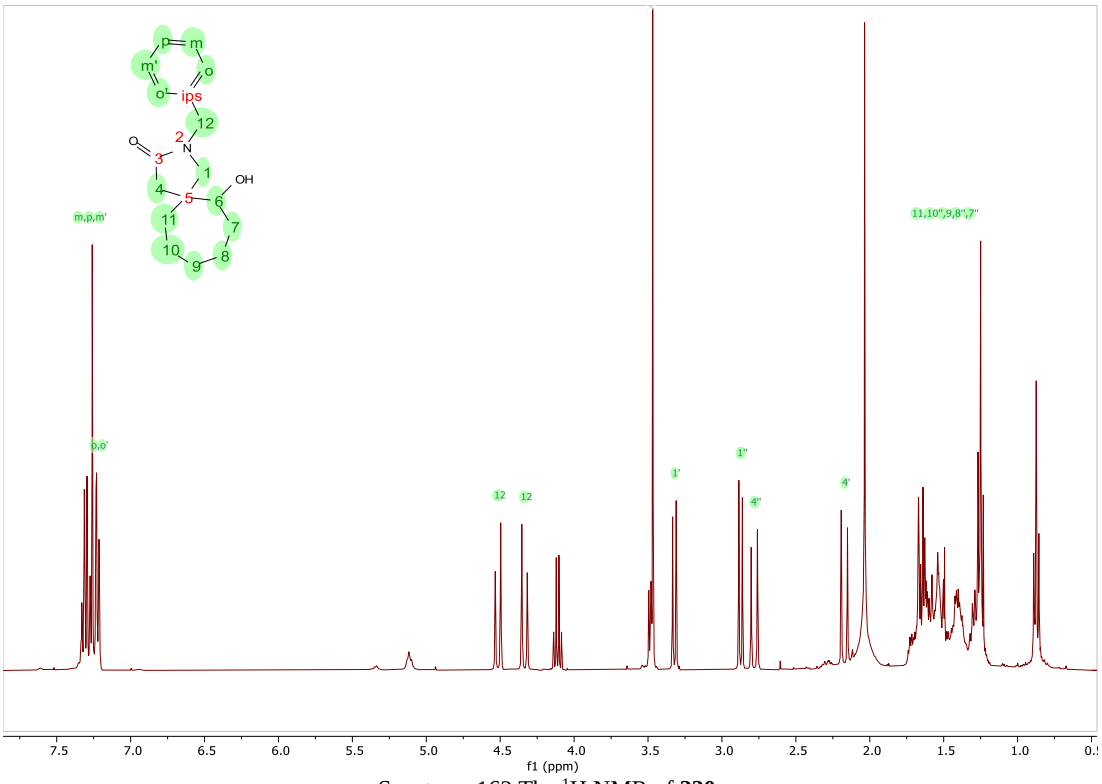
Spectrum 159 The COSY NMR of **218**.



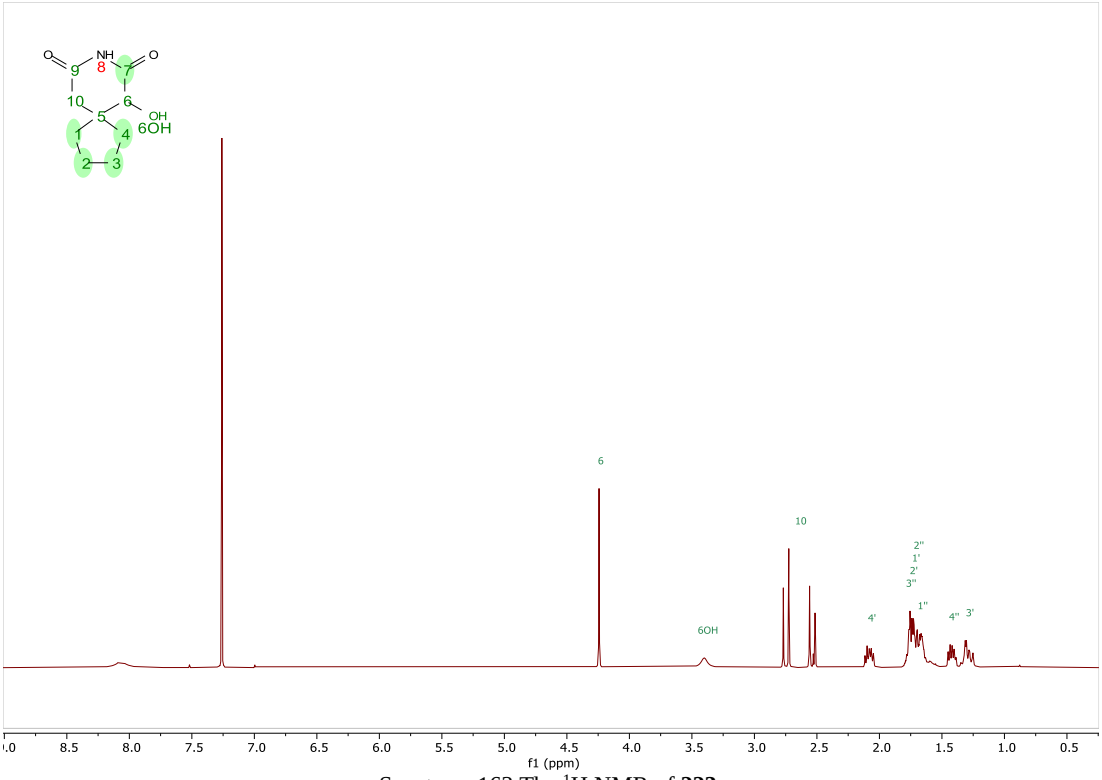
Spectrum 160 The ^{1}H NMR of **219**.



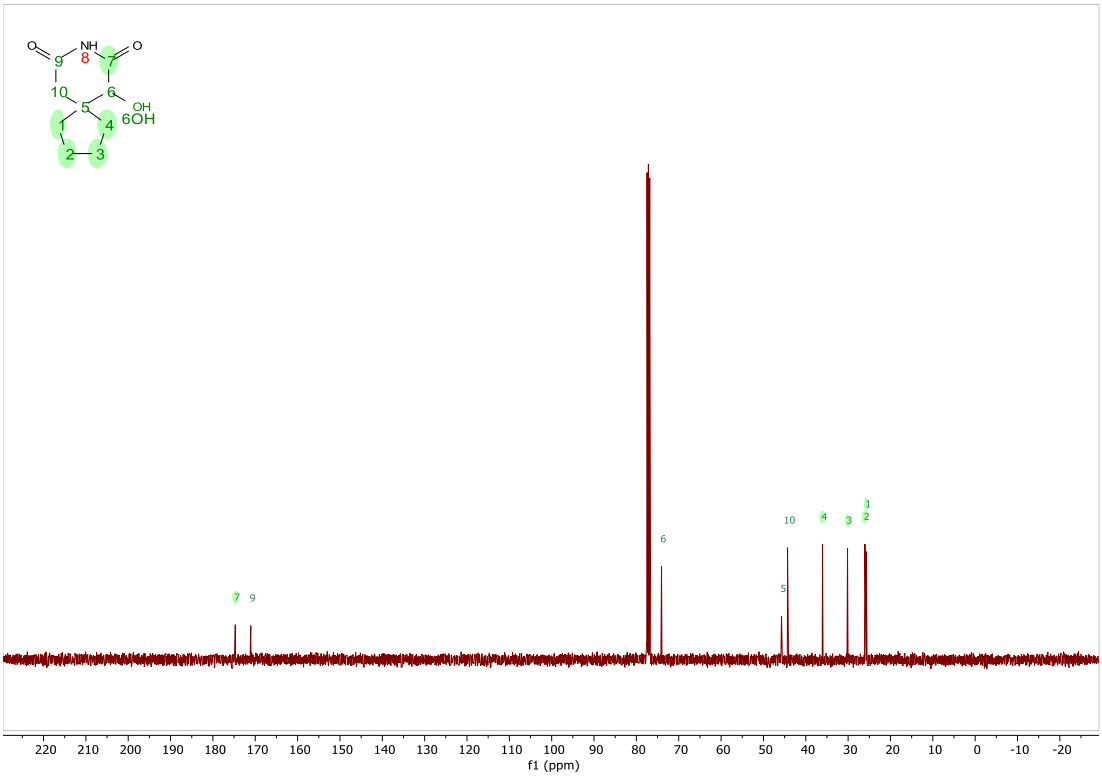
Spectrum 161 The COSY NMR of **219**.



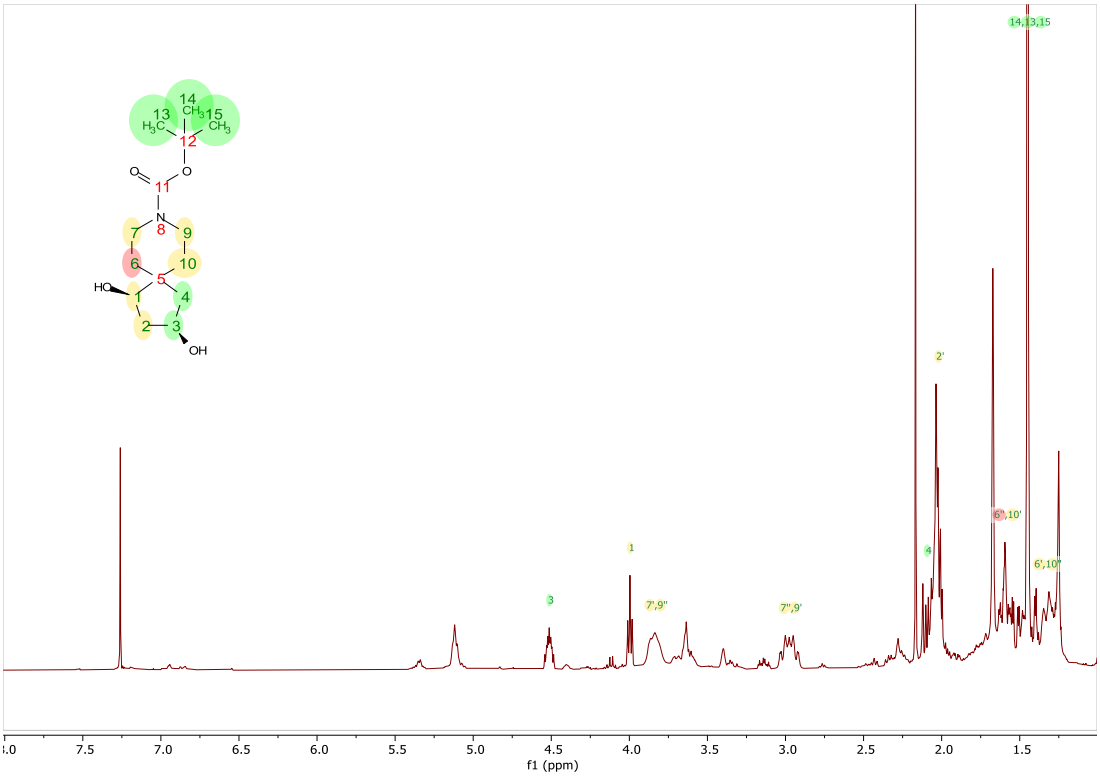
Spectrum 162 The ^{1}H NMR of **220**.



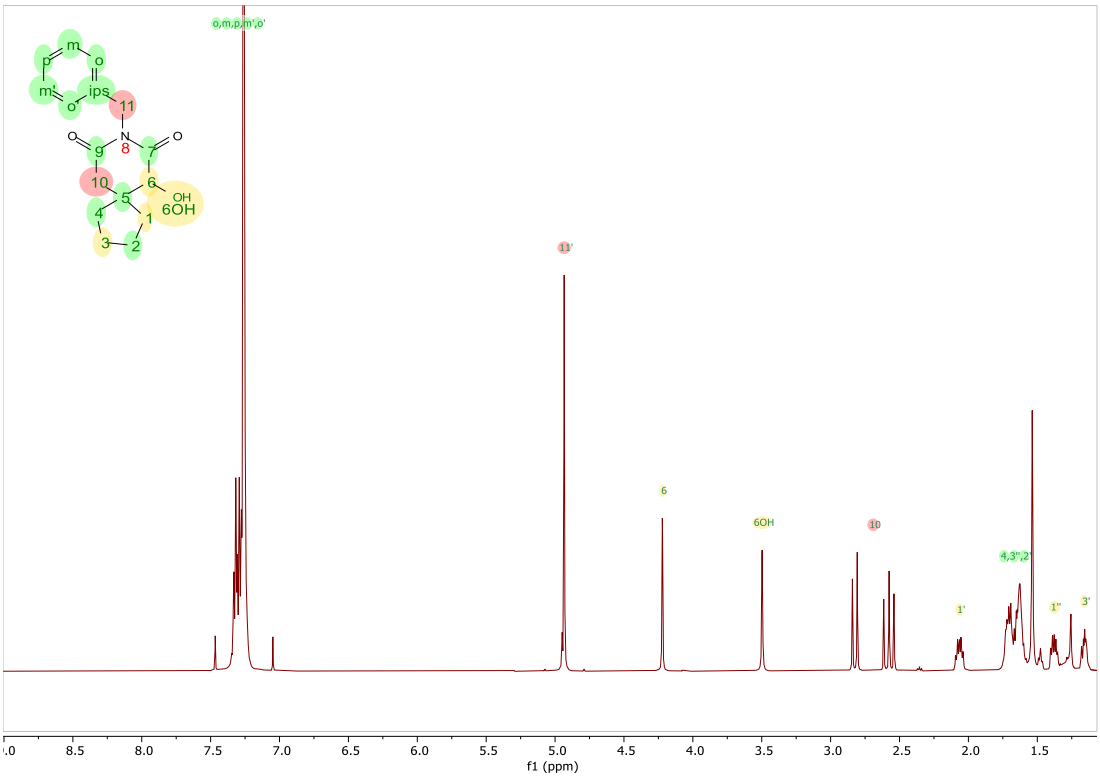
Spectrum 163 The ^{1}H NMR of **223**.



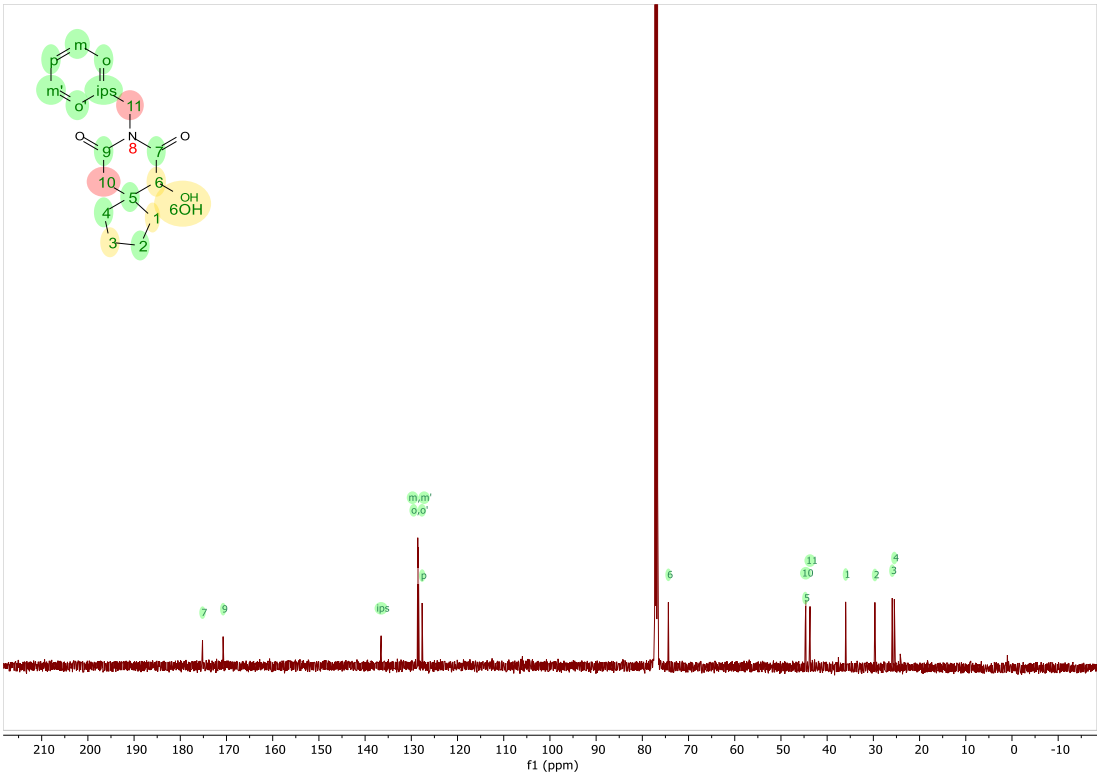
Spectrum 164 The ^{13}C NMR of **223**.



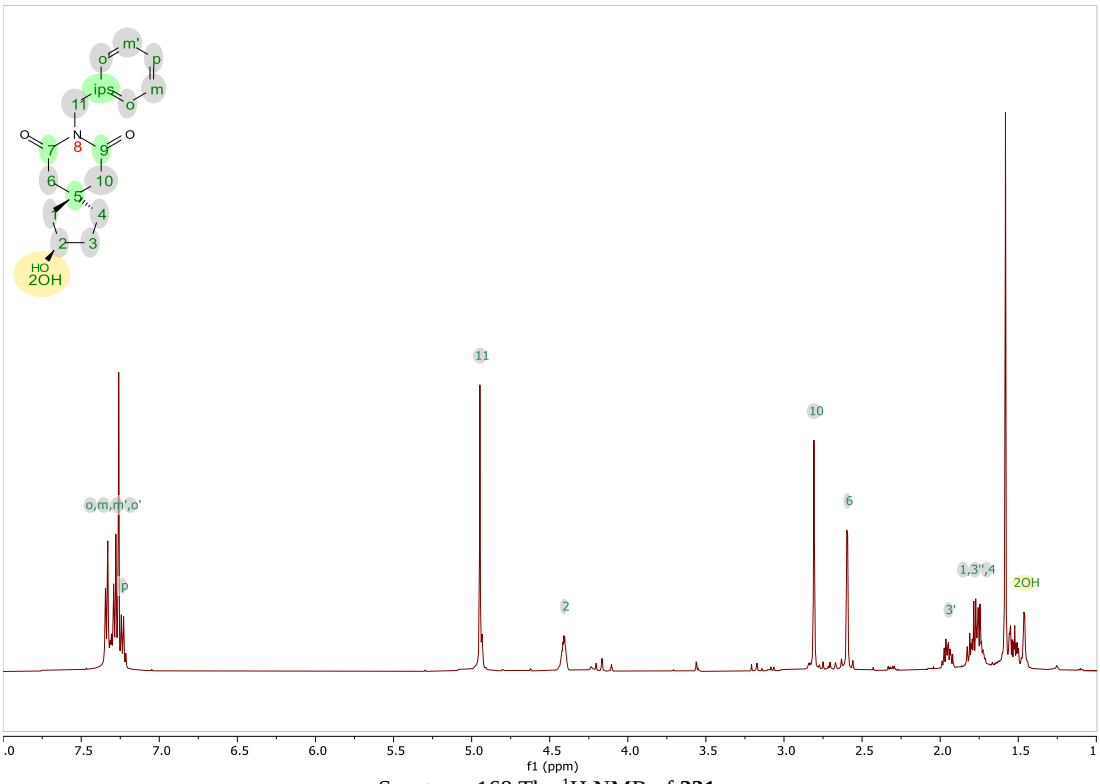
Spectrum 165 The ^{1}H NMR of **228**.



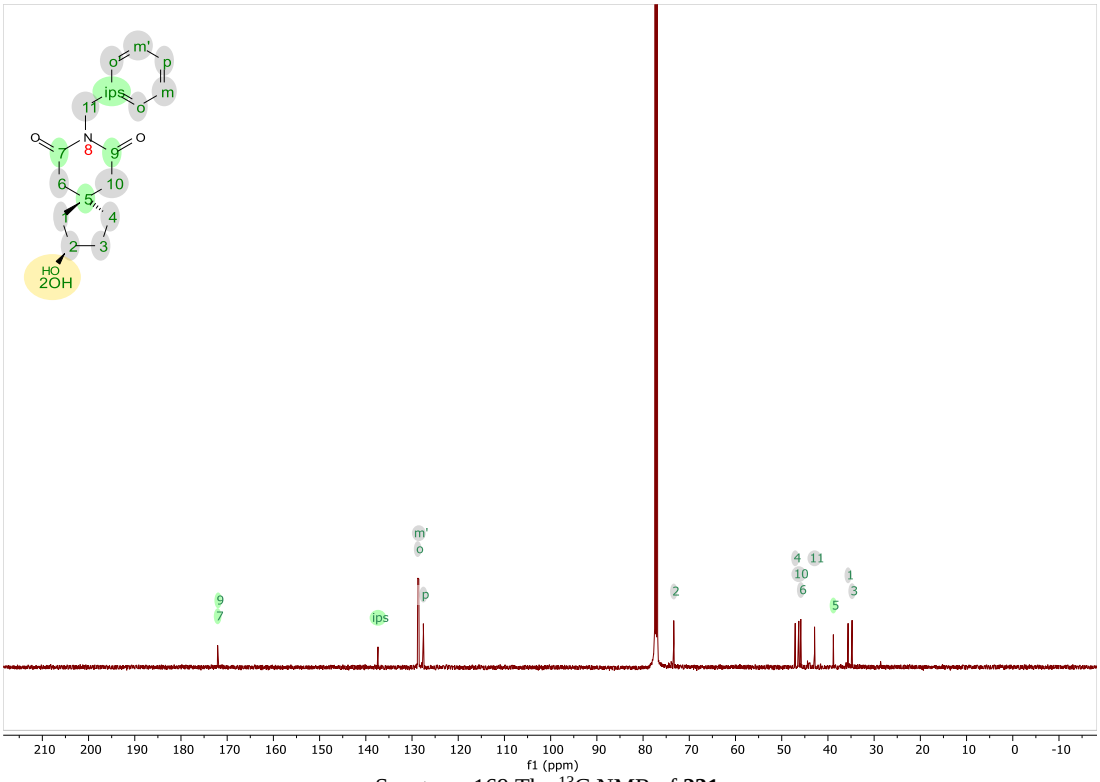
Spectrum 166 The ^{1}H NMR of **230**.



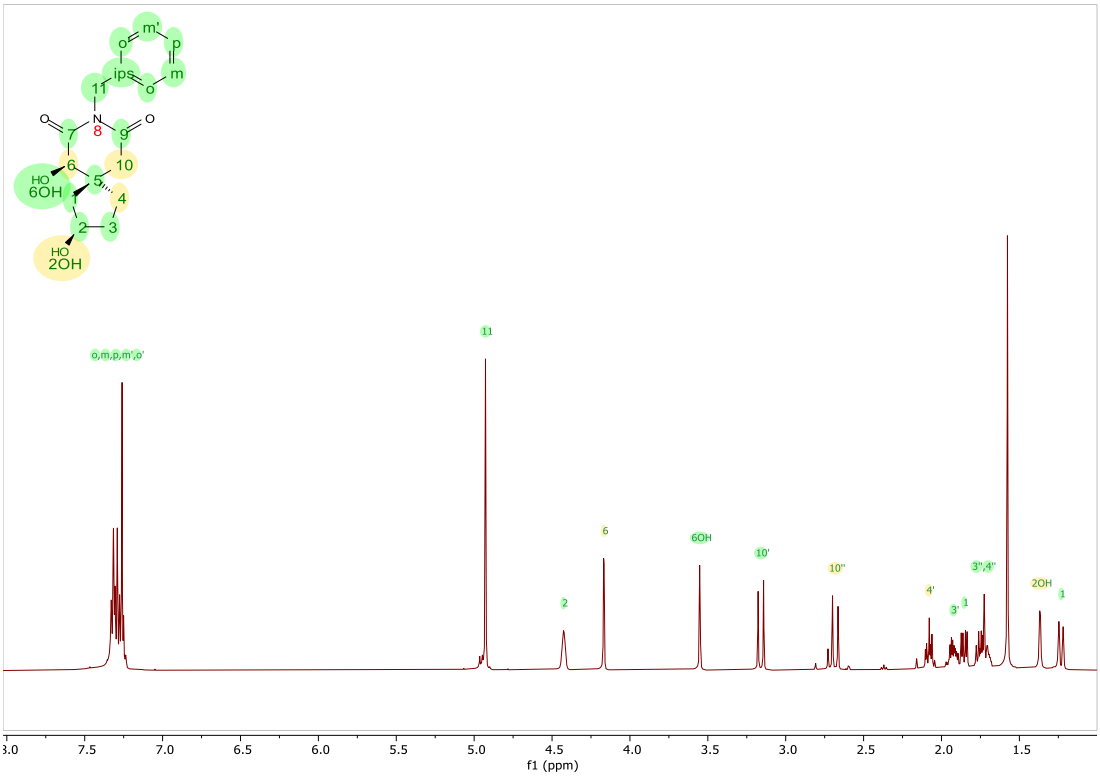
Spectrum 167 The ^{13}C NMR of **230**.



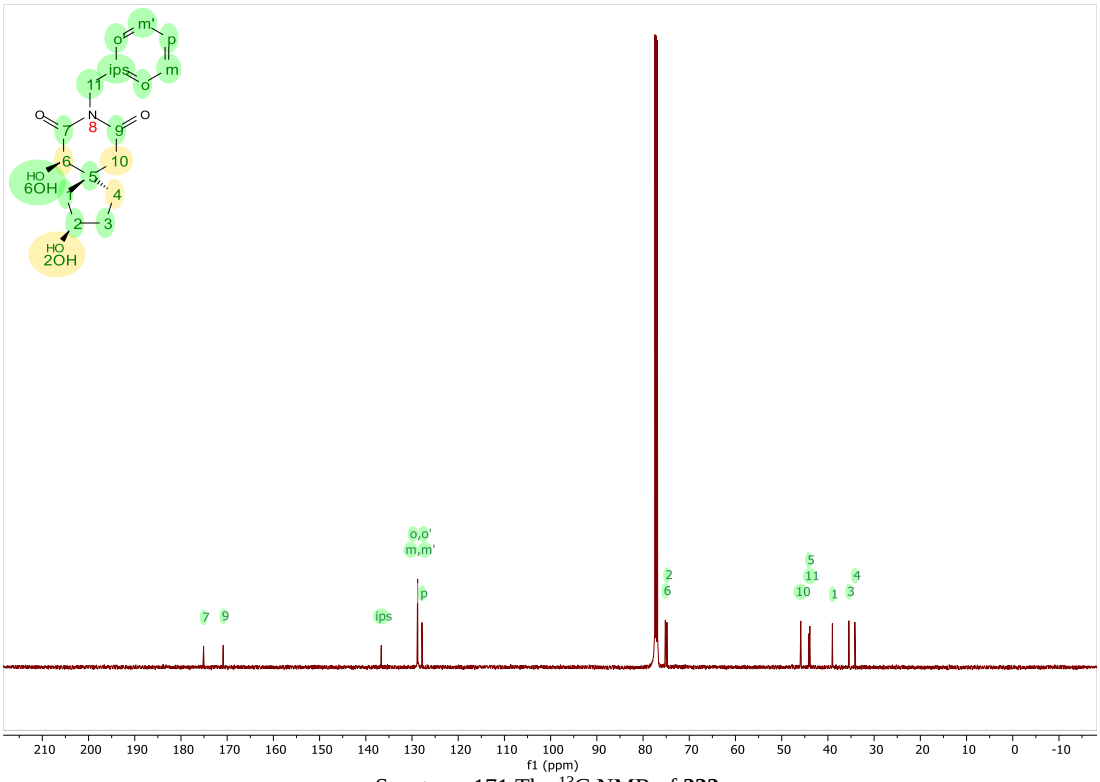
Spectrum 168 The ^{1}H NMR of **231**.



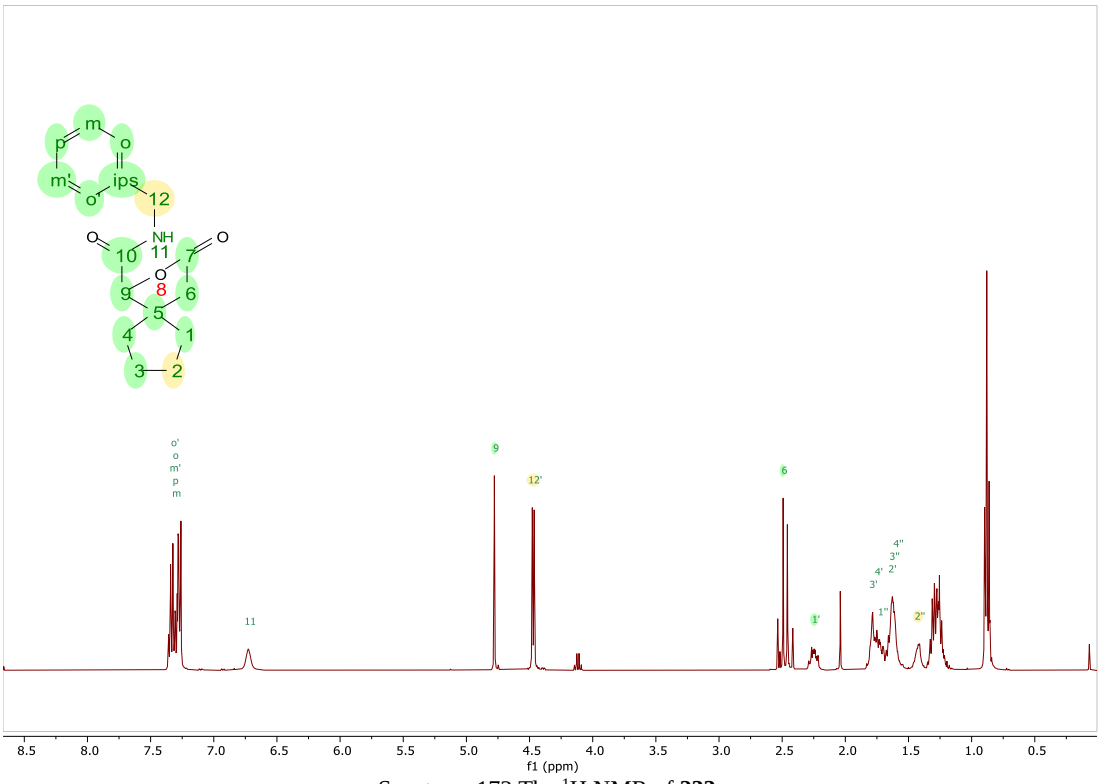
Spectrum 169 The ^{13}C NMR of **231**.



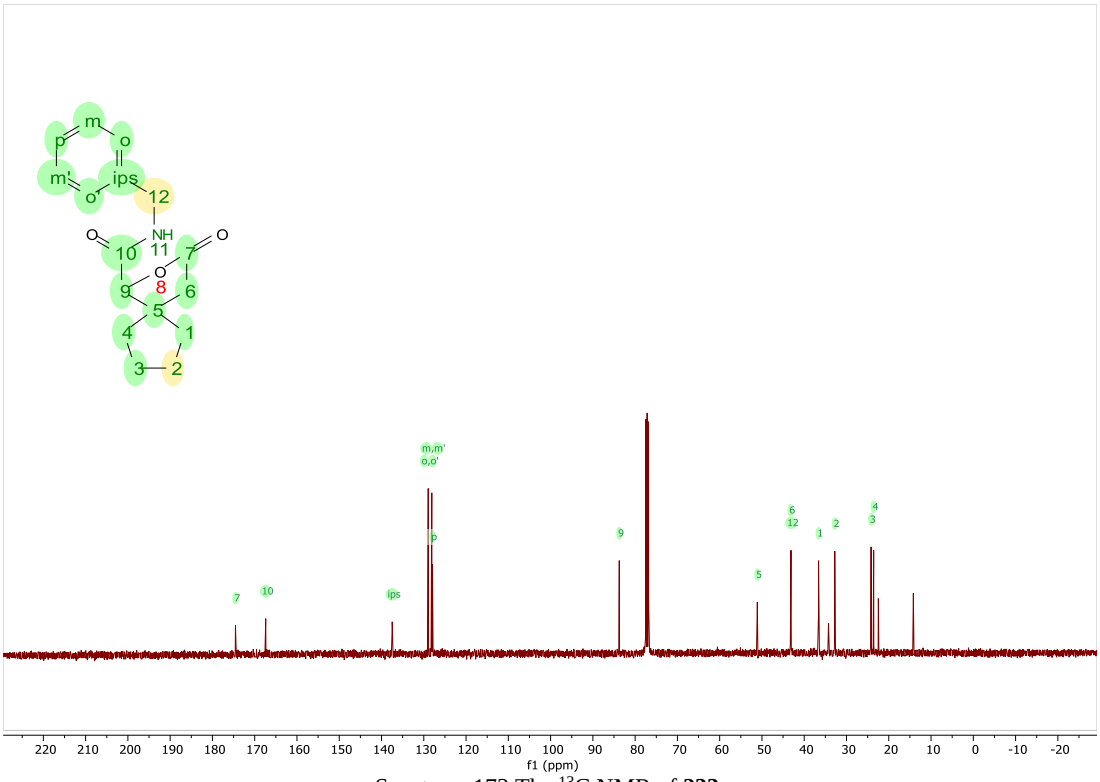
Spectrum 170 The ^{1}H NMR of **232**.



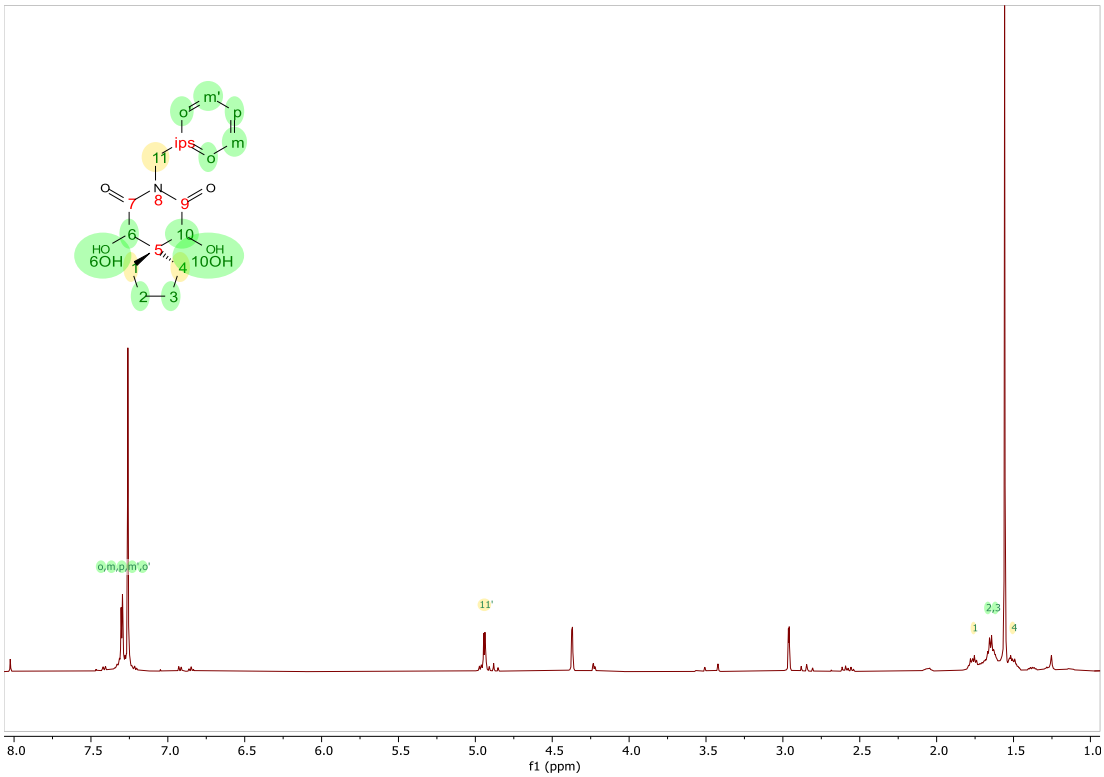
Spectrum 171 The ^{13}C NMR of **232**.



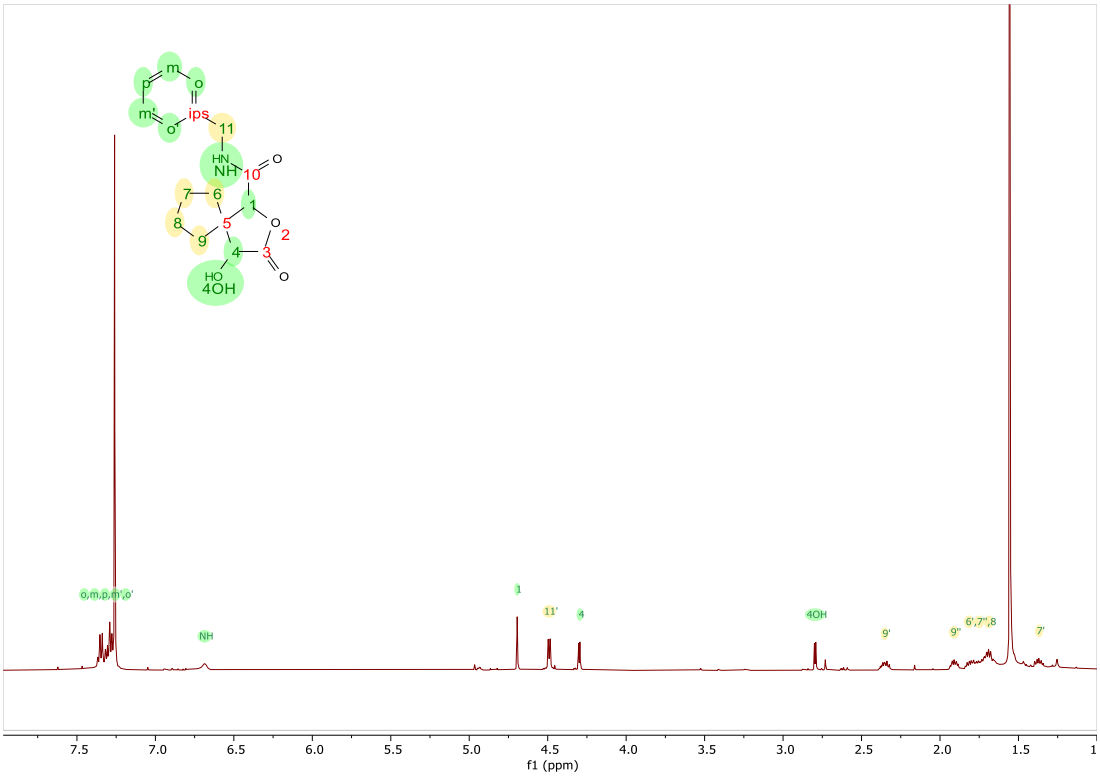
Spectrum 172 The ^{1}H NMR of **233**.



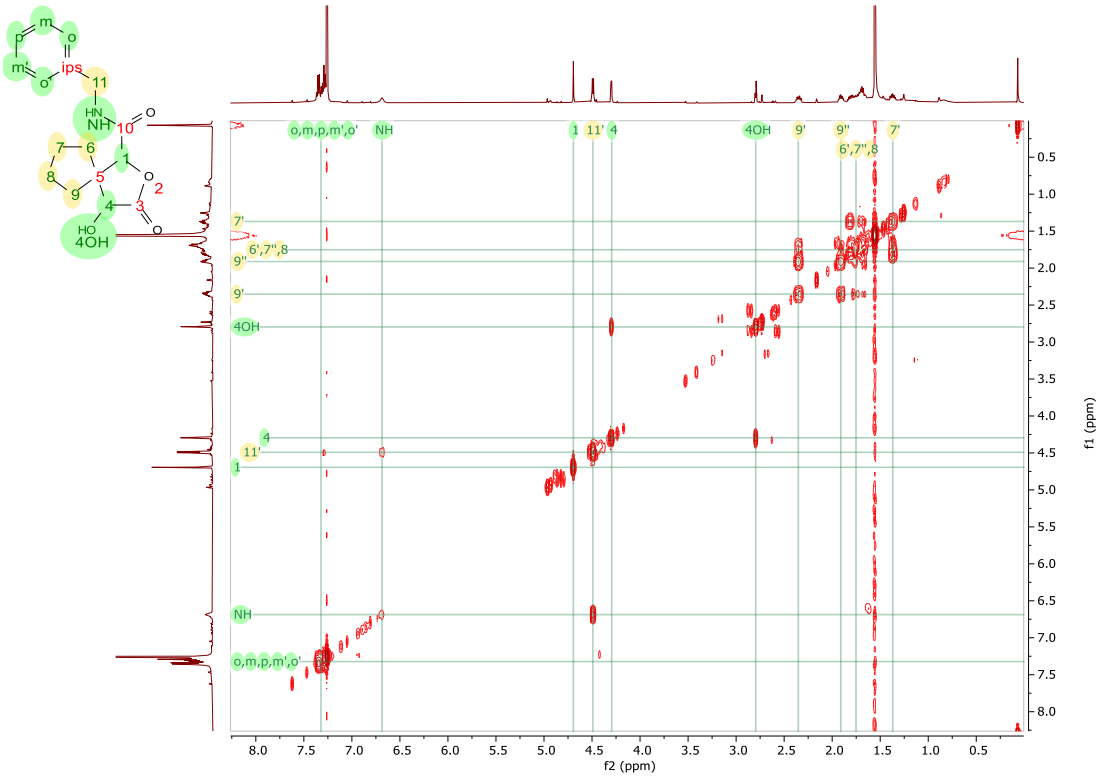
Spectrum 173 The ^{13}C NMR of **233**.



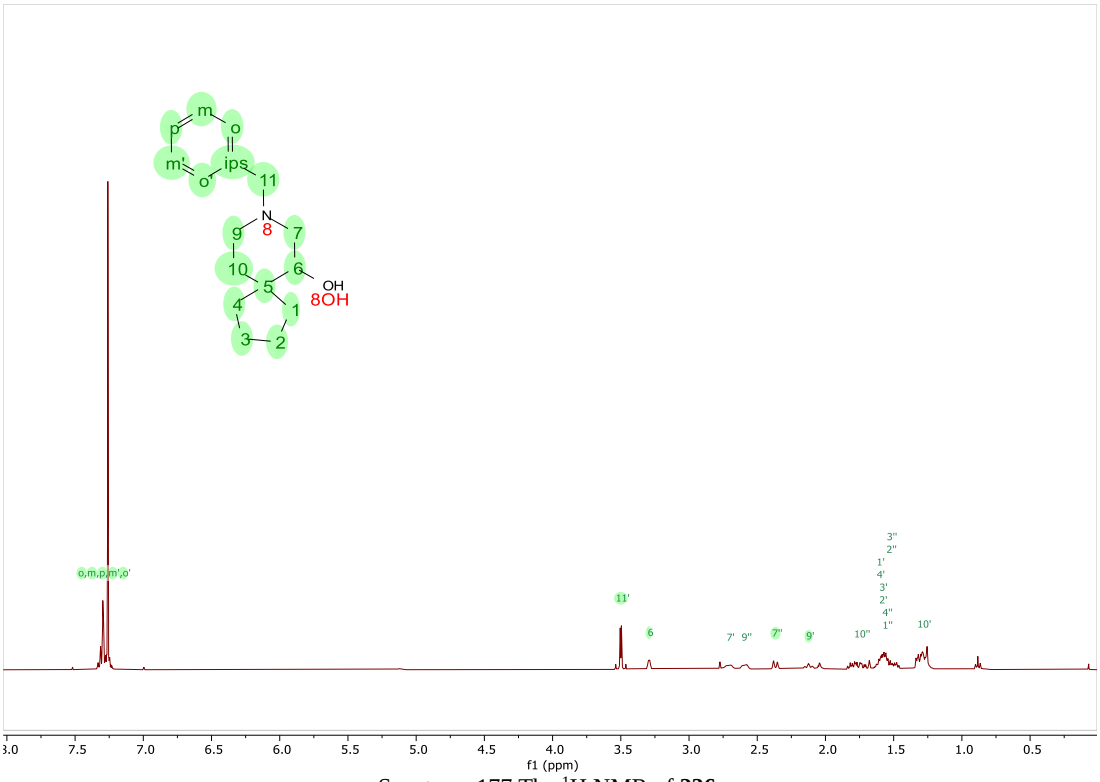
Spectrum 174 The ^{1}H NMR of **234**.



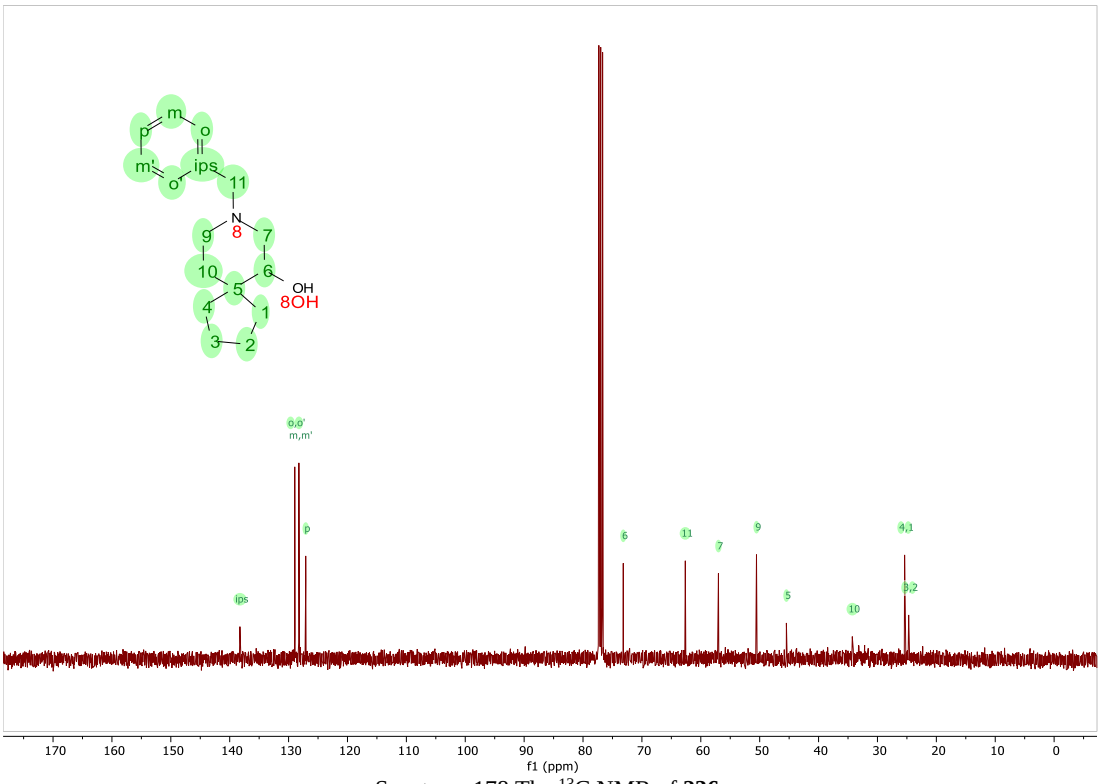
Spectrum 175 The ^{1}H NMR of **235**.



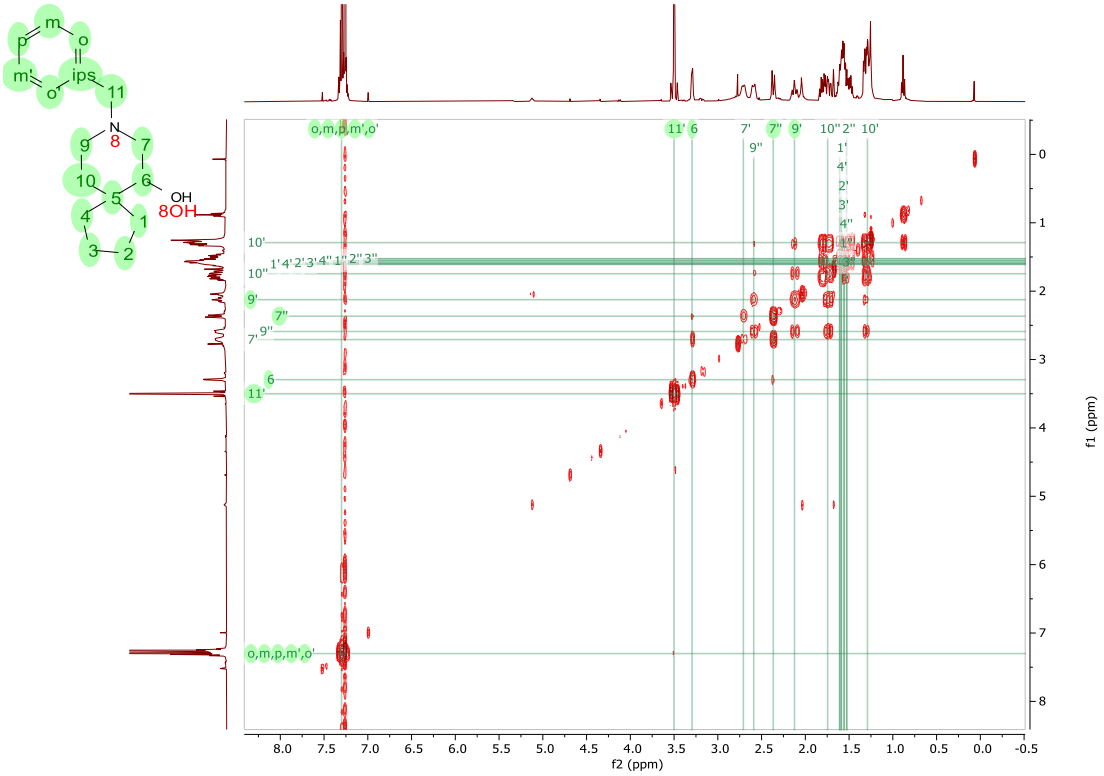
Spectrum 176 The COSY NMR of **235**.



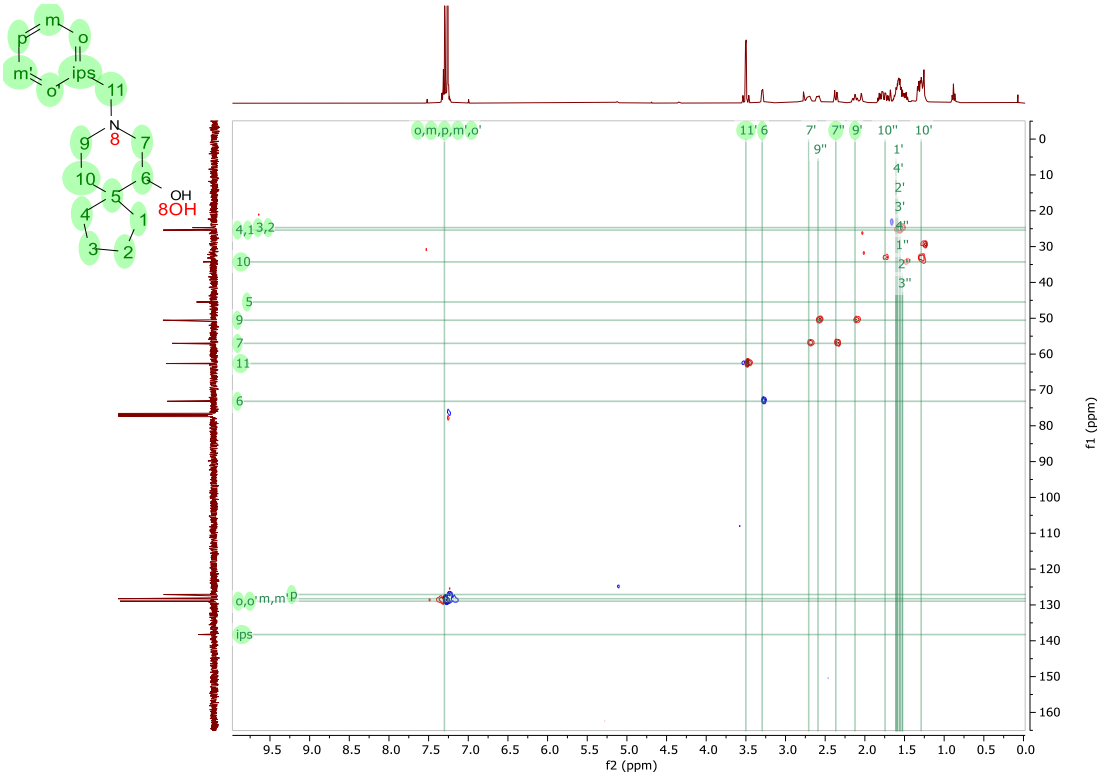
Spectrum 177 The ^{1}H NMR of **236**.



Spectrum 178 The ^{13}C NMR of **236**.



Spectrum 179 The COSY NMR of **236**.



Spectrum 180 The HSQC NMR of **236**.

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