

Pocket Guide to Antiretroviral Resistance Mutations

NRTIs

	ZDV	d4T	TDF	ABC	ddl	3TC	FTC	
41L	Orange	Orange	Yellow	Yellow	Yellow	Blue	Blue	I
67NG	Orange	Orange	Yellow	Yellow	Yellow	Blue	Blue	
70R	Orange	Blue	Yellow	Yellow	Yellow	Blue	Blue	
210W	Orange	Orange	Yellow	Yellow	Yellow	Blue	Blue	
215FY	Red	Orange	Yellow	Yellow	Yellow	Blue	Blue	
219QEN	Orange	Orange	Blue	Yellow	Yellow	Blue	Blue	
44AD	Blue	Blue	Blue	Blue	Blue	Blue	Blue	II
69DN	Blue	Blue	Blue	Blue	Yellow	Blue	Blue	
69 ins	Orange	Orange	Orange	Orange	Orange	Orange	Orange	
75TMA	Blue	Orange	Blue	Orange	Orange	Blue	Blue	
118I	Blue	Blue	Blue	Blue	Blue	Blue	Blue	
65R	Green	Blue	Orange	Orange	Orange	Orange	Orange	III
74VI	Green	Blue	Orange	Orange	Orange	Orange	Orange	
115F	Green	Blue	Orange	Orange	Orange	Orange	Orange	
184VI	Green	Blue	Orange	Orange	Orange	Orange	Orange	
62V	Blue	Blue	Blue	Blue	Blue	Blue	Blue	IV
75I	Blue	Blue	Blue	Blue	Blue	Blue	Blue	
77L	Blue	Blue	Blue	Blue	Blue	Blue	Blue	
116Y	Blue	Blue	Blue	Blue	Blue	Blue	Blue	
151M	Orange	Orange	Yellow	Yellow	Yellow	Yellow	Yellow	

Footnotes:

- Thymidine analogue mutations (TAMs). These mutations are selected predominantly by the thymidine analogues ZDV and d4T but cause cross-resistance to other NRTIs. They promote the unblocking of NRTI-terminated virus DNA chains. They are nonpolymorphic. T215S/C/D/E/I/V are transitional mutations that do not cause resistance by themselves but usually indicate evolution from a virus that once contained T215F/Y.
- TAMs-associated mutations. These mutations generally occur in combination with TAMs. E44D and V118I are polymorphic, occurring in 2% of untreated persons.
- Discriminatory mutations. These mutations prevent the addition of NRTIs to the growing viral DNA chain.
- Q151M pathway mutations. These mutations nearly always accompany the multi-NRTI-resistant mutation Q151M.

Abbreviations: 3TC, lamivudine; ABC, abacavir; FTC, emtricitabine; d4T, stavudine; ddl, didanosine; TDF, tenofovir; ZDV, zidovudine

NNRTIs

	NVP	DLV	EFV	
98G	Yellow	Blue	Blue	I
100I	Yellow	Orange	Orange	
101E	Yellow	Orange	Orange	
101P	Red	Orange	Orange	
103NS	Red	Orange	Orange	
106A	Red	Orange	Orange	
106M	Yellow	Orange	Orange	II
108I	Yellow	Orange	Orange	
179DE	Yellow	Yellow	Yellow	
181CIV	Red	Red	Red	
188L	Red	Yellow	Yellow	
188CH	Red	Yellow	Yellow	
190A	Red	Green	Orange	III
190S	Red	Green	Orange	
190EQC	Red	Yellow	Orange	
225H	Yellow	Green	Yellow	III
227L	Yellow	Green	Yellow	
230L	Red	Red	Orange	
236L	Green	Red	Orange	
238TN	Yellow	Orange	Orange	
318F	Yellow	Orange	Orange	

Footnotes:

- These mutations are clustered between positions 98-108.
- These mutations are clustered between positions 179-190.
- These mutations are clustered between positions 225-238.

* A98S, K101R/Q, K103R, V106I, V179I, and K238R are polymorphic substitutions that have little if any effect on drug resistance with the following possible exception: K103R may slightly increase the level of resistance to each of the NNRTIs when present with V179D.

Abbreviations: DLV, delavirdine; EFV, efavirenz; NVP, nevirapine

PIs

	NFV	SQV	IDV	RTV	APV	LPV	ATV	
30N	Red	Orange	Yellow	Yellow	Blue	Yellow	Yellow	I
48VM	Red	Orange	Yellow	Yellow	Blue	Yellow	Yellow	
50V	Orange	Orange	Yellow	Yellow	Blue	Yellow	Yellow	
50L	Green	Green	Green	Green	Green	Green	Green	
82ATFS	Orange	Yellow	Red	Red	Orange	Red	Red	
84VAC	Red	Red	Orange	Orange	Orange	Orange	Orange	
90M	Red	Red	Orange	Orange	Orange	Orange	Orange	II
46IL	Orange	Blue	Orange	Orange	Yellow	Red	Orange	
47A	Orange	Blue	Orange	Orange	Yellow	Red	Orange	
47V	Orange	Blue	Orange	Orange	Yellow	Red	Orange	
53L	Blue	Orange	Orange	Orange	Yellow	Red	Orange	
54VTAS	Orange	Blue	Orange	Orange	Yellow	Red	Orange	
54ML	Orange	Blue	Orange	Orange	Yellow	Red	Orange	III
23I	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	
24I	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	
32I	Yellow	Yellow	Orange	Orange	Orange	Orange	Orange	
33F	Yellow	Yellow	Orange	Orange	Orange	Orange	Orange	
73CSTA	Yellow	Yellow	Orange	Orange	Orange	Orange	Orange	
76V	Yellow	Yellow	Orange	Orange	Orange	Orange	Orange	IV
88S	Red	Blue	Yellow	Blue	Green	Red	Red	
88D	Orange	Blue	Yellow	Blue	Green	Red	Red	
101VFR	Blue	Blue	Blue	Blue	Blue	Blue	Blue	
20MRIT	Blue	Blue	Blue	Blue	Blue	Blue	Blue	
36IV	Blue	Blue	Blue	Blue	Blue	Blue	Blue	
63P	Blue	Blue	Blue	Blue	Blue	Blue	Blue	
71VTI	Blue	Blue	Blue	Blue	Blue	Blue	Blue	IV
77I	Blue	Blue	Blue	Blue	Blue	Blue	Blue	

Footnotes:

- "Major" mutations. With the exception of L90M, these mutations are in the substrate cleft. Each by itself is capable of reducing susceptibility to one or more PIs. With the exception of V82I, which does not cause drug resistance, mutations at these positions are nonpolymorphic in that they do not occur in PI-naive persons.
- "Flap" mutations. These mutations are in the protease flap and are second in importance only to the "Major" mutations. Some may cause resistance by themselves, but these mutations are more often accessory. They are also nonpolymorphic.
- Other nonpolymorphic PI-resistance mutations. These mutations indicate past PI exposure. Several cause resistance by themselves but more often they are accessory.
- With the exception of L10F, these mutations are polymorphic. They contribute to resistance only when present in combination with one or more category I-III mutations.

Abbreviations: APV, amprenavir; ATV, atazanavir; IDV, indinavir; LPV, lopinavir; NFV, nelfinavir; RTV, ritonavir; SQV, saquinavir

COLOR LEGEND

Red	High-level resistance	Blue	Contributes to resistance
Orange	Intermediate resistance	Grey	No resistance
Yellow	Low-level resistance	Green	Hypersusceptibility

Last Updated: September 2005

This resource is updated at regular intervals. Please visit clinicaloptions.com/pocket to receive email bulletins advising you when revisions are available. A range of additional resources on HIV drug resistance are available at the Stanford University HIV Drug Resistance Database Web site at <http://hivdb.stanford.edu>