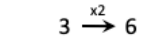
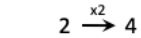
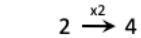
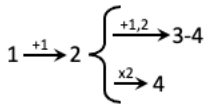
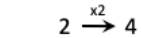
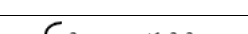
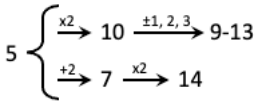
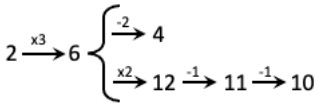
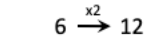
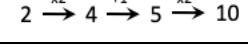
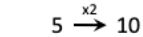
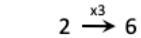
Summary of the evolutionary pathways taken, showing the internal duplications (REPEAT UNITS) in the integral transmembrane transport proteins that mediate transport by any of several mechanisms.

The results presented in this table include several examples of the well-documented, identifiable, duplication/triplication events that gave rise to members of particular (sub or super)families. All these sub- or super-families are included in TCDB with description of both the families and the family member proteins when known. The table presents (1) the TC# for the (sub/super)family (column 1), (2) its abbreviated family designation (column 2), and (3) a diagram of the pathway of evolution (column 3), indicating the duplication (x2) or triplication (x3) event that occurred during the family evolution (column 3). The data reveal (a) the number of TMSs in the original repeat unit, (b) the number of TMSs in the resultant duplicated or triplicated protein, or the TMS additions (+1, +2, or +3 TMSs) or deletions (-1, -2 or -3 TMSs).

TC#	(Super)family	Evolutionary path
1.A.8	MIP	
1.A.28	UT/NQR	
1.A.72	Mer	
1.A.77	MCU	
1.E	Holins *	
1.H.1	4JC	
2.A.1	MFS **	
2.A.3	APC	
2.A.4	CDF	
2.A.6	RND	
2.A.7	DMT	
2.A.28	BART	
2.A.29	MC	

TC#	(Super)family	Evolutionary path
2.A.43	TOG	$4 \xrightarrow{x2} 8 \xrightarrow{-1} 7$
2.A.45	ArsB (IT Superfamily)	$6 \xrightarrow{x2} 12$
2.A.66	MOP	$6 \xrightarrow{x2} 12$
2.A.67	OPT ***	$2 \xrightarrow{x2} 4 \xrightarrow{x2} 8 \xrightarrow{x2} 16 (\xrightarrow{+1} 17)$
2.A.75	LysE	$3 \xrightarrow{x2} 6$
3.A.1	ABC1	$2 \xrightarrow{x3} 6$
3.A.1	ABC2	$3 \xrightarrow{x2} 6$
3.A.1	ABC3	$4 \xrightarrow{x2} 8 \begin{cases} \xrightarrow{+2} 10 \\ \xrightarrow{+4} 12 \end{cases}$
4.A.1	PTS-GFL	$5 \xrightarrow{+5} 10$
4.A.5	PTS-AG	$5 \xrightarrow{x2} 10$
9.A.55	CuR	$4 \xrightarrow{x2} 8 \xrightarrow{x2} 16$

Some unusual features of a few families are also considered as follows:

* Holins (subclass 1.E) are proteins that form “holes” in the cytoplasmic membrane of an organism, allowing the export of cell wall digesting enzymes, usually in preparation for cell lysis and programmed cell death. There are 66 such families of holins in subclass 1.E, and some of these belong to seven superfamilies with various numbers of families. The different evolutionary pathways taken by the different families are indicated. Thus, not all holin families arose via the same evolutionary pathway.

** In the superfamily, MFS, there are over 100 families, each usually specific for a particular class of transport compounds. Virtually all MFS proteins have at least 12 TMSs that arose first, by duplication of the 3 TMS unit that duplicated to give 6 TMS proteins, and then duplicated again to give rise to the typical 12 TMSs protein members. However, many MFS transporters have 2 extra TMSs sandwiched in between the two 6 TMS repeat units.

*** In family OPT (TC# 2.A.67), three successive duplications (2 TMSs duplicating to 4 TMSs, then 4 duplicating to 8 TMSs, and then 8 duplicating to 16 TMSs. This is the major topology exhibited by many members of the family, but some have an extra TMS at their C-termini, leading to proteins with 17 putative TMSs.