

Heterocyst lineage description system (HLDS)

1. Lineage of all cells within a trichome is unequivocally described.
2. Premises:
 - (1) A trichome consists of linearly arranged vegetative cells and heterocysts.
 - (2) A vegetative cell divides by binary fission.
 - (3) Heterocysts are terminally developed cells and do not divide.
 - (4) During the growth of a trichome, the arrangement of cells is kept without reversal.
3. Procedure:
 - (1) All cells within the starting trichome are numbered consecutively in binary, such as 00, 01, 10 and 11, or 000, 001, 010, 011, 100, 101, 110, and 111 (not all numbers are necessary).
 - (2) If a cell divides, the daughter cells are given an additional 0 or 1, depending on the position. For example, if the cell 01 divides, the daughter cells are named 010 and 011, respectively.
 - (3) In this way, all cells within a trichome are arranged according to the binary numbering. Null precedes 0, which precedes 1.
 - (4) Finally, heterocysts are marked H.
4. In this system, all cells are numbered before they exist. The actual pattern of cell division is described by determining the time for all possible cell divisions. In other words, development of cell division pattern is described by a set of division times. If no division occurred within the experimental time period, the division time is marked -1. For example, for the first cell 000, the series of seven numbers or a vector, “54, 39, -1, 18, 57, 39, 60”, unequivocally describes the fate of its offspring until the third division. To describe the cell fate until the fourth division, a series of 15 numbers is sufficient. As the cell order is not reversed, a series of such vectors describes all cell lineage.
5. The data are stored as an Excel file, and converted into a tab-delimited text file, which gives a tree file using a Perl script CLutil.pl. The tree file is used to create a lineage tree diagram, using NJplot or TreeView program.

Example: Each line represents a cell. At the beginning, cells 000, 001, 010 etc are present.

Upon division at time 21, the cell 000 gave daughter cells 0000 and 0001, both of which divide at time 36 to give daughter cell pairs: 00000 and 00001 or 00010 and 00011. The cells 00001, 00010 and 00011 did not divide during the time span of the experiment (shaded). The division times for these cells are described as -1. The cell 00110 ceased to divide and became a heterocyst.

0	0	0									
										57	
				0	0	1					
									36		
				0	1	0					
										-1	
				0	1	1					
								21			
				1	0	0					
										-1	
				1	0	1					
									36		
				1	1	0					
										-1	
				1	1	1					
0	0	1		0	0	0					
										45	
				0	0	1					
									30		
				0	1	0					
										45	
				0	1	1					
								12			
				1	0	0					
										-1	H
				1	0	1					
									30		
				1	1	0					
										39	
				1	1	1					
0	1	0		0	0	0					
										51	
				0	0	1					
									36		
				0	1	0					
										-1	
				0	1	1					
								12			
				1	0	0					
										-1	
				1	0	1					
									36		
				1	1	0					
										54	
				1	1	1					

Example tree diagram describing a cell lineage:

The numbers corresponding to the initial cells are omitted.

