

Table S1. The estimated parameters for classes in soil.

Class labels	α	$\beta - 1$	$\gamma - \beta$
Actinobacteria	-3.04792	-0.12294	0.612325
Gammaproteobacteria	-1.50804	-0.04381	0.188613
Planctomycetia	-3.45082	-0.03984	0.543796
Sphingobacteria	-2.61844	-0.02774	-0.07861
Clostridia	-1.99488	-0.06993	0.389862
Deltaproteobacteria	-2.54422	-0.02209	0.186643
Flavobacteria	-2.97553	0.001003	-0.0036
Bacilli	-2.54422	-0.01289	0.414958
Alphaproteobacteria	-2.28667	-0.14739	0.596544
Betaproteobacteria	-3.39786	-0.0921	0.453879
Acidobacteria_Gp3	-4.01063	-0.05732	1.09616
Bacteroidia	-3.62767	0.018083	0.643633
Anaerolineae	-3.84028	-0.22657	1.85437
Opitutae	-4.33402	-0.38781	-28.7292

The parameter $\alpha = \log(\pi/1-\pi)$, where π represents the relative abundance of a class in a sample, should be negative because π is generally a small number. For a specific taxonomic label, $\beta - 1$, which represents the contribution of an associated OTU not belonging to the given class should be negative, while $\gamma - \beta$, which represents the contribution of an associated OTU belong to the given class, should be positive.

Table S2. The estimated parameters for classes in human intestine.

Class labels	α	$\beta-1$	$\gamma-\beta$
Bacteroidia	-1.59451	-0.0838	0.23792
Clostridia	0.025001	-0.162777	0.179655
Actinobacteria	-3.1619	-0.024032	0.63121
Negativicutes	-2.60605	-0.029054	0.804757
Bacilli	-3.66356	0.016028	1.4007
Verrucomicrobiae	-3.95763	-0.12555	1.36297
Fusobacteria	-3.66356	-0.073908	1.56494
Gammaproteobacteria	-3.33545	-0.182498	1.3901
Erysipelotrichia	-3.24519	-0.119514	0.117823
Betaproteobacteria	-3.33545	-0.471557	2.82252

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