

# The *E. coli* molecular phenotype under different growth conditions

## Supplementary materials

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## Supplementary Figures

A	mRNA		Protein		
	1.structural constituent of ribosome ▼▼▼		1.L-lactate dehydrogenase activity ▼▼▼		lowMg
	2.rRNA binding ▼▼▼		2.lactate dehydrogenase activity ▼▼▼		
	3.structural molecule activity ▼▼▼				
	4.RNA binding ▼▼▼				
	5.RNA-dependent ATPase activity ▼▼▼				
	1.energy transducer activity ▲		1.L-lactate dehydrogenase activity ▼▼▼		highMg
	2.alkanesulfonate transporter activity ▲		2.lactate dehydrogenase activity ▼▼▼		
	3.oxidoreductase activity ▲▼				
			1.binding ▼		highNa
			2.protein binding ▼		
			3.structural constituent of ribosome ▼▼▼		
			4.small molecule binding ▼		
			5.nucleotide binding ▼		
	1.structural constituent of ribosome ▼▼▼		1.ATP binding ▼▼		glycerol
	2.structural molecule activity ▼▼▼		2.adenyl ribonucleotide binding ▼▼		
	3.rRNA binding ▼▼▼		3.adenyl nucleotide binding ▼▼		
	4.RNA binding ▼▼▼		4.molecular transducer activity ▼▼▼		
	5.RNA binding ▼▼▼		5.oxidoreductase activity, acting on the CH-OH group of donors, quinon		
	1.gluconate transmembrane transporter activity ▲				gluconate
	2.aldonate transmembrane transporter activity ▲				
	1.structural constituent of ribosome ▲▲		1.catalytic activity ▲▲		lactate
	2.structural molecule activity ▲▲		2.lactate dehydrogenase activity ▲▲		
	3.rRNA binding ▲▲		3.hydrolase activity ▲▲		
	4.RNA binding ▲▲		4.L-lactate dehydrogenase activity ▲▲		
	5.lactate dehydrogenase activity ▲▲				
B	mRNA		Protein		
	1.ATPase activity ▼▼▼				lowMg
	2.hydrolase activity, acting on acid anhydrides, catalyzing transmembra				
	3.oligopeptide-transporting ATPase activity ▼▼▼				
	4.peptide-transporting ATPase activity ▼▼▼				
	5.ATPase activity, coupled ▼▼▼				
					highMg
	1.carbohydrate transmembrane transporter activity ▼▼		1.protein binding ▼		highNa
	2.carbohydrate transporter activity ▼▼		2.binding ▼		
	3.polyol transmembrane transporter activity ▼▼		3.structural constituent of ribosome ▼▼▼		
	4.alcohol transmembrane transporter activity ▼▼		4.ion binding ▼		
	5.organic hydroxy compound transmembrane transporter activity ▼▼		5.structural molecule activity ▼▼▼		
			1.oxidoreductase activity ▼▼		glycerol
			2.oxidoreductase activity, acting on the aldehyde or oxo group of donors		
			3.coenzyme binding ▼		
			4.oxidoreductase activity, acting on the CH-OH group of donors, quinon		
			5.cofactor binding ▼		
			1.siderophore transmembrane transporter activity ▼▼▼		gluconate
			2.2,3-dihydroxybenzoate-serine ligase activity ▼▼▼		
			3.siderophore transporter activity ▼▼▼		
			4.iron chelate transmembrane transporter activity ▼▼▼		
			1.lactate dehydrogenase activity ▲▲		lactate
			2.oxidoreductase activity, acting on CH-OH group of donors ▲▲		
			3.binding ▲▲		
			4.L-lactate dehydrogenase activity ▲▲		
			5.cofactor binding ▲▲		

Figure S1: **Significantly differentially expressed molecular functions, as determined by GO annotations.** For each condition, we show the top-5 differentially expressed molecular functions according to either mRNA or protein abundances. Empty boxes indicate that no differentially expressed pathways were found. The arrows next to pathway names indicate the proportion of up- and down-regulated genes among the significantly differentially expressed genes in this pathway. One up arrow indicates that 60% or more of the genes are up-regulated, two arrows correspond to 80% or more genes, and three arrows correspond to 95% or more genes being up-regulated. Similarly, down arrows indicate the proportion of down-regulated genes. (A) Exponential phase. (B) Stationary phase.

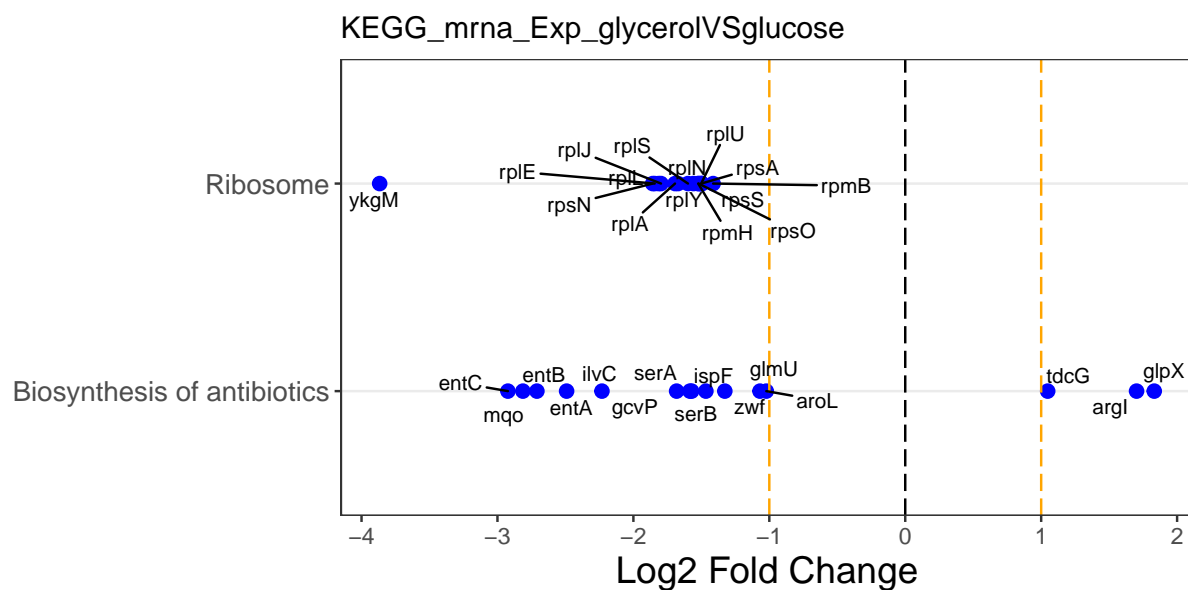


Figure S2: **Significantly differentially expressed KEGG pathways and associated genes with glycerol as carbon source, as determined by mRNA abundances in exponential phase.** The top 2 differentially expressed KEGG pathways are shown along the  $y$  axis, and the relative fold change of the corresponding genes is shown along the  $x$  axis. We show up to 10 of the most significantly changed pathways and for each pathway we show up to 15 of the most significantly changing genes.

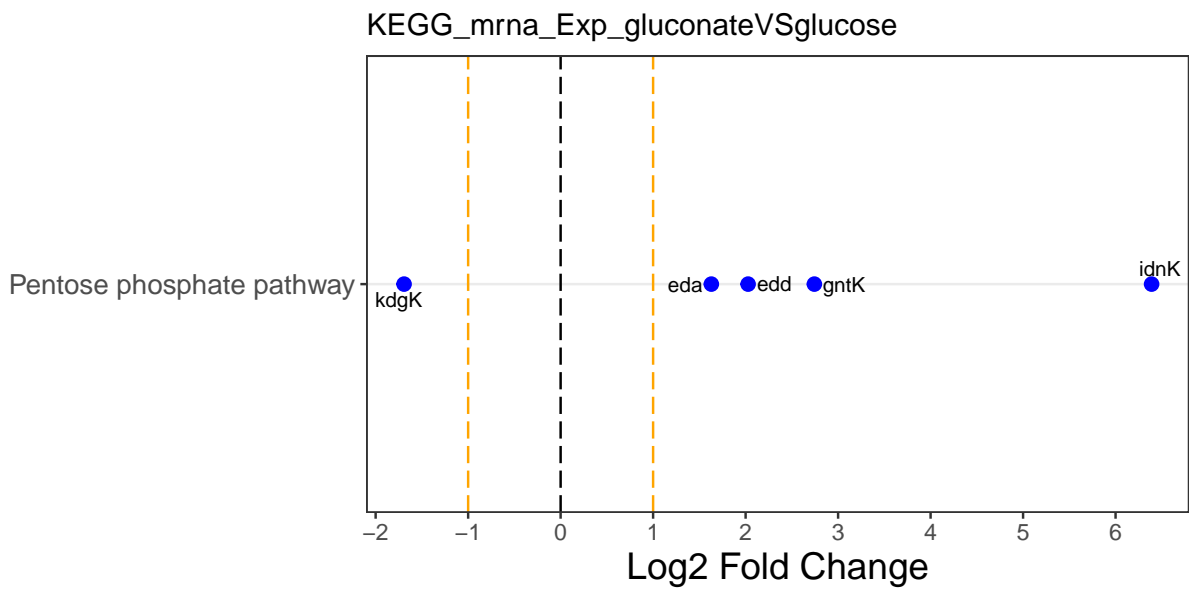


Figure S3: **Significantly differentially expressed KEGG pathway and associated genes with gluconate as carbon source, as determined by mRNA abundances in exponential phase.** The top differentially expressed KEGG pathway is shown along the  $y$  axis, and the relative fold change of the corresponding genes is shown along the  $x$  axis. We show up to 10 of the most significantly changed pathways and for each pathway we show up to 15 of the most significantly changing genes.

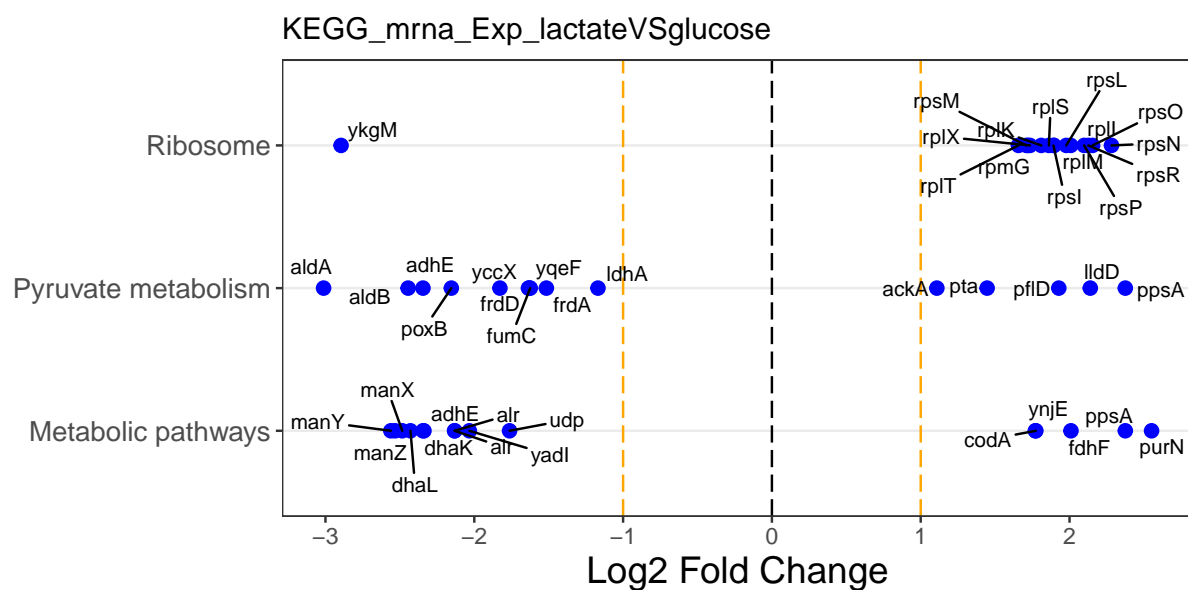


Figure S4: **Significantly differentially expressed KEGG pathways and associated genes with lactate as carbon source, as determined by mRNA abundances in exponential phase.** The top 3 differentially expressed KEGG pathways are shown along the  $y$  axis, and the relative fold change of the corresponding genes is shown along the  $x$  axis. We show up to 10 of the most significantly changed pathways and for each pathway we show up to 15 of the most significantly changing genes.

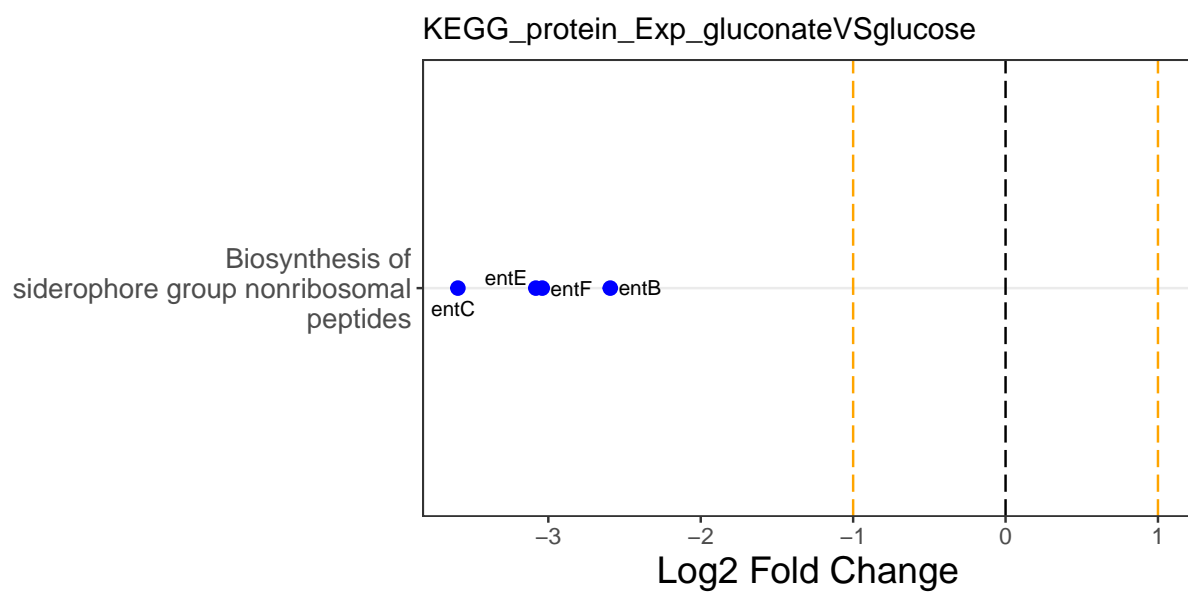


Figure S5: **Significantly differentially expressed KEGG pathway and associated genes with gluconate as carbon source, as determined by protein abundances in exponential phase.** The top differentially expressed KEGG pathway is shown along the  $y$  axis, and the relative fold change of the corresponding genes is shown along the  $x$  axis. We show up to 10 of the most significantly changed pathways and for each pathway we show up to 15 of the most significantly changing genes.



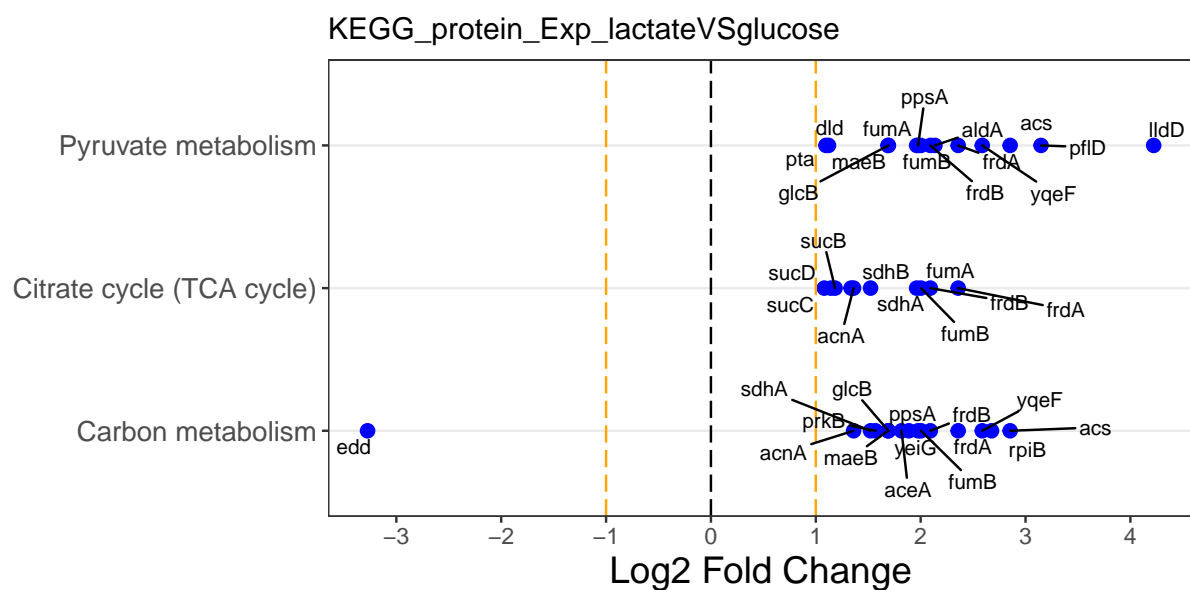


Figure S6: **Significantly differentially expressed KEGG pathways and associated genes with lactate as carbon source, as determined by protein abundances in exponential phase.** The top 3 differentially expressed KEGG pathways are shown along the  $y$  axis, and the relative fold change of the corresponding genes is shown along the  $x$  axis. We show up to 10 of the most significantly changed pathways and for each pathway we show up to 15 of the most significantly changing genes.

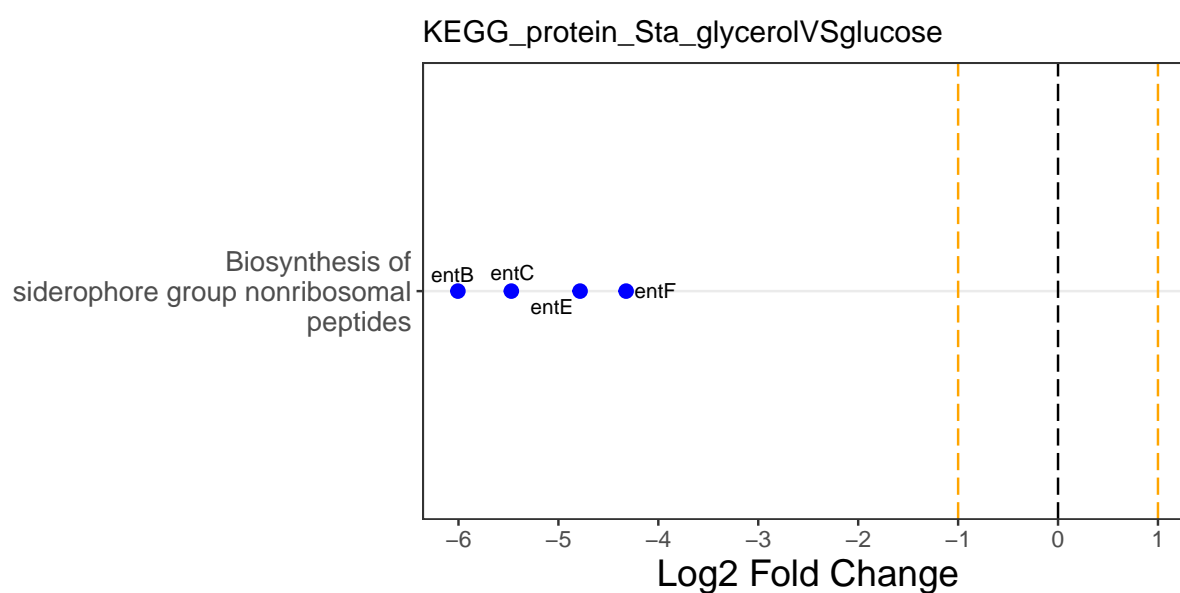


Figure S7: **Significantly differentially expressed KEGG pathway and associated genes with glycerol as carbon source, as determined by protein abundances in stationary phase.** The top differentially expressed KEGG pathway is shown along the  $y$  axis, and the relative fold change of the corresponding genes is shown along the  $x$  axis. We show up to 10 of the most significantly changed pathways and for each pathway, we show up to 15 of the most significantly changing genes.

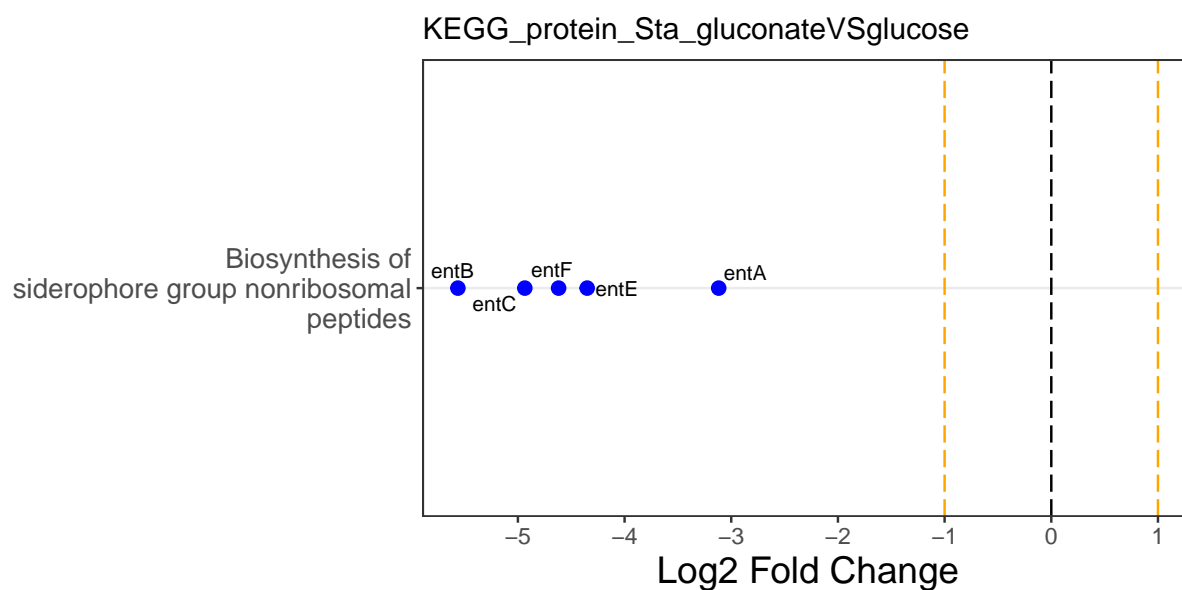


Figure S8: **Significantly differentially expressed KEGG pathway and associated genes with gluconate as carbon source, as determined by protein abundances in stationary phase.** The top differentially expressed KEGG pathway is shown along the  $y$  axis, and the relative fold change of the corresponding genes is shown along the  $x$  axis. We show up to 10 of the most significantly changed pathways and for each pathway, we show up to 15 of the most significantly changing genes.

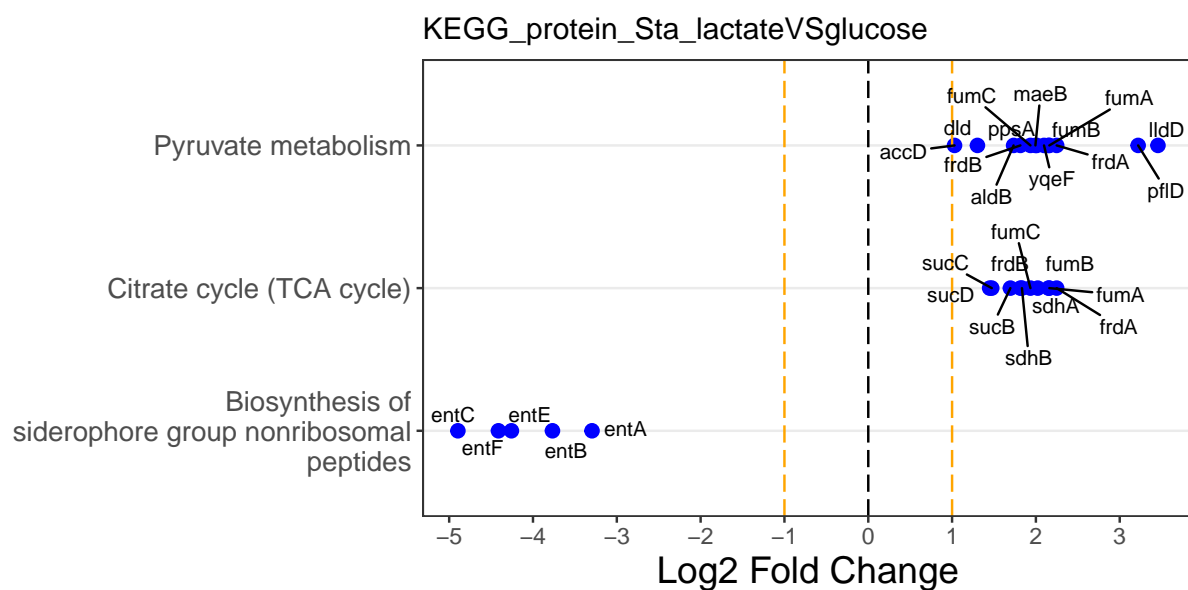


Figure S9: **Significantly differentially expressed KEGG pathways and associated genes with lactate as carbon source, as determined by protein abundances in stationary phase.** The top 3 differentially expressed KEGG pathways are shown along the  $y$  axis, and the relative fold change of the corresponding genes is shown along the  $x$  axis. We show up to 10 of the most significantly changed pathways and for each pathway, we show up to 15 of the most significantly changing genes.

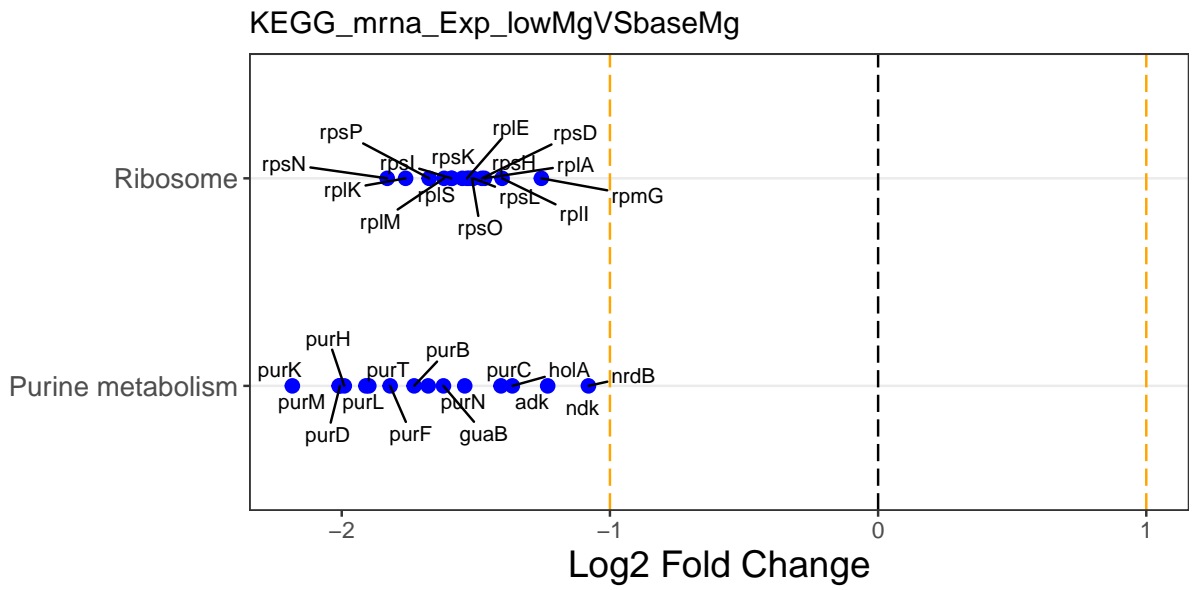


Figure S10: **Significantly differentially expressed KEGG pathways and associated genes with low  $Mg^{2+}$  levels, as determined by mRNA abundances in exponential phase.** The top 2 differentially expressed KEGG pathways are shown along the  $y$  axis, and the relative fold change of the corresponding genes is shown along the  $x$  axis. We show up to 10 of the most significantly changed pathways and for each pathway, we show up to 15 of the most significantly changing genes.

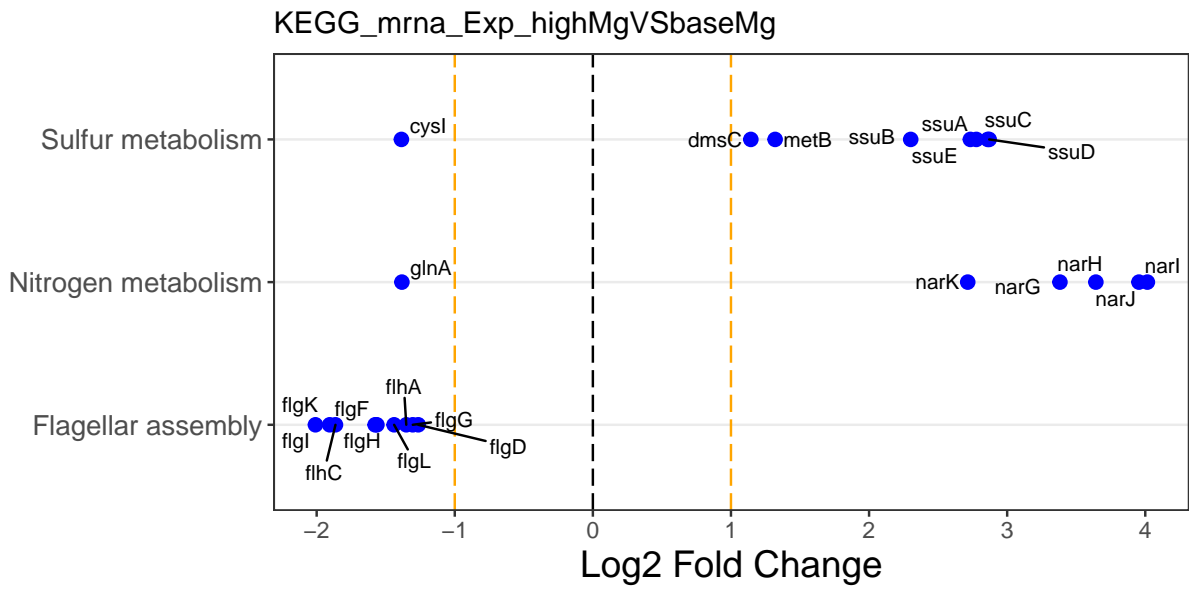


Figure S11: **Significantly differentially expressed KEGG pathways and associated genes with high  $\text{Mg}^{2+}$  levels, as determined by mRNA abundances in exponential phase.** The top 3 differentially expressed KEGG pathways are shown along the  $y$  axis, and the relative fold change of the corresponding genes is shown along the  $x$  axis. We show up to 10 of the most significantly changed pathways and for each pathway, we show up to 15 of the most significantly changing genes.

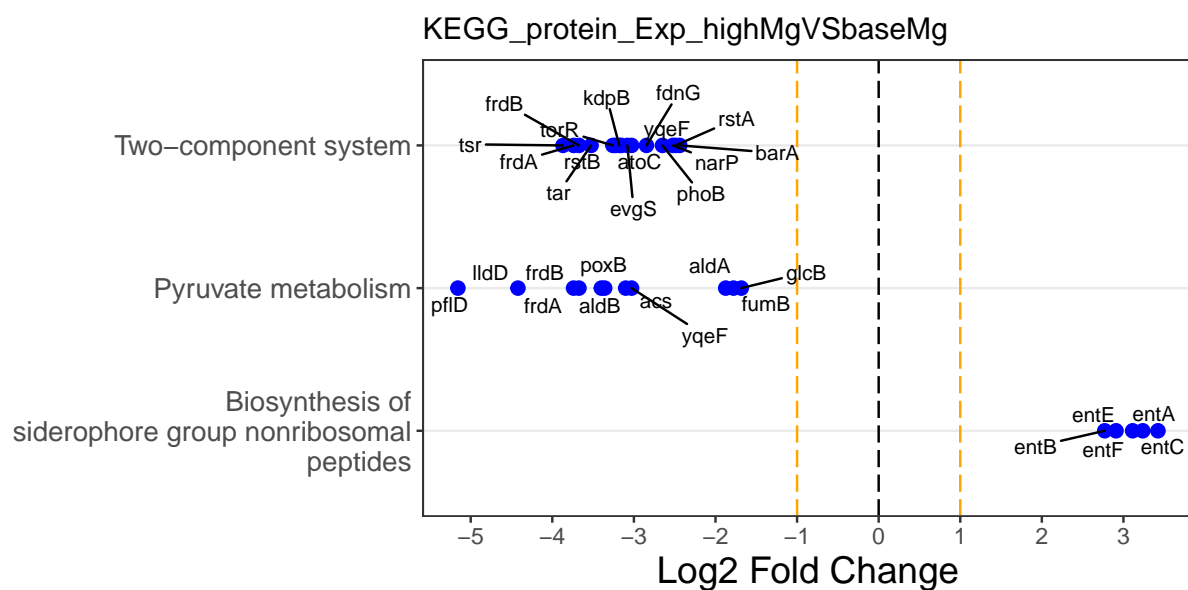


Figure S12: **Significantly differentially expressed KEGG pathways and associated genes with high  $\text{Mg}^{2+}$  levels, as determined by protein abundances in exponential phase.** The top 3 differentially expressed KEGG pathways are shown along the  $y$  axis, and the relative fold change of the corresponding genes is shown along the  $x$  axis. We show up to 10 of the most significantly changed pathways and for each pathway, we show up to 15 of the most significantly changing genes.

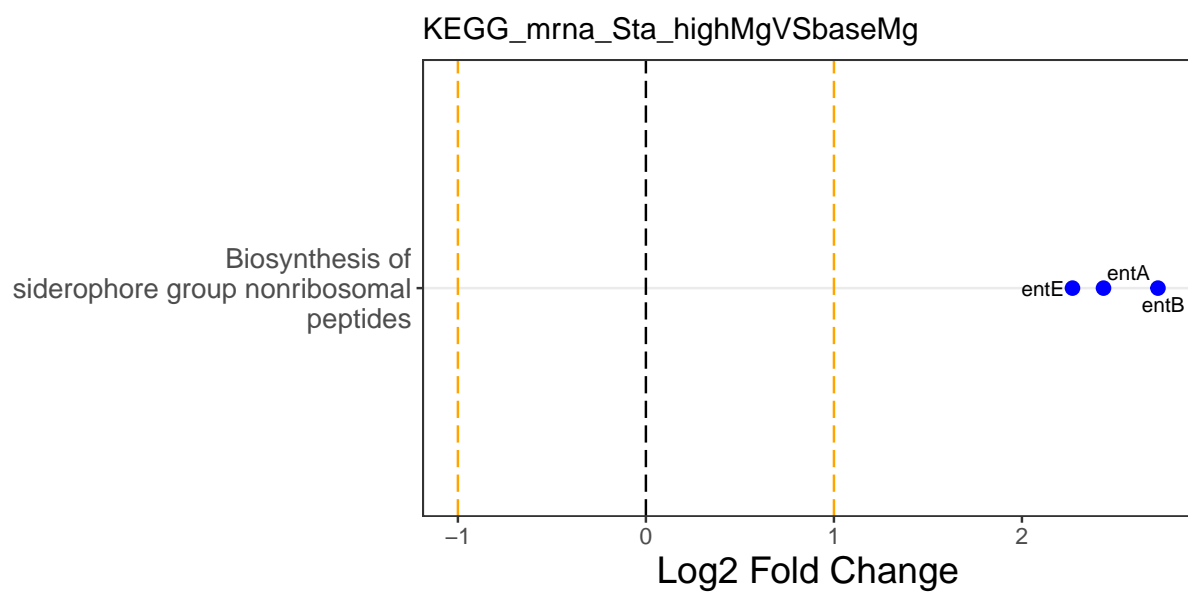


Figure S13: **Significantly differentially expressed KEGG pathway and associated genes with high  $\text{Mg}^{2+}$  levels, as determined by mRNA abundances in stationary phase.** The top differentially expressed KEGG pathway is shown along the  $y$  axis, and the relative fold change of the corresponding genes is shown along the  $x$  axis. We show up to 10 of the most significantly changed pathways and for each pathway, we show up to 15 of the most significantly changing genes.



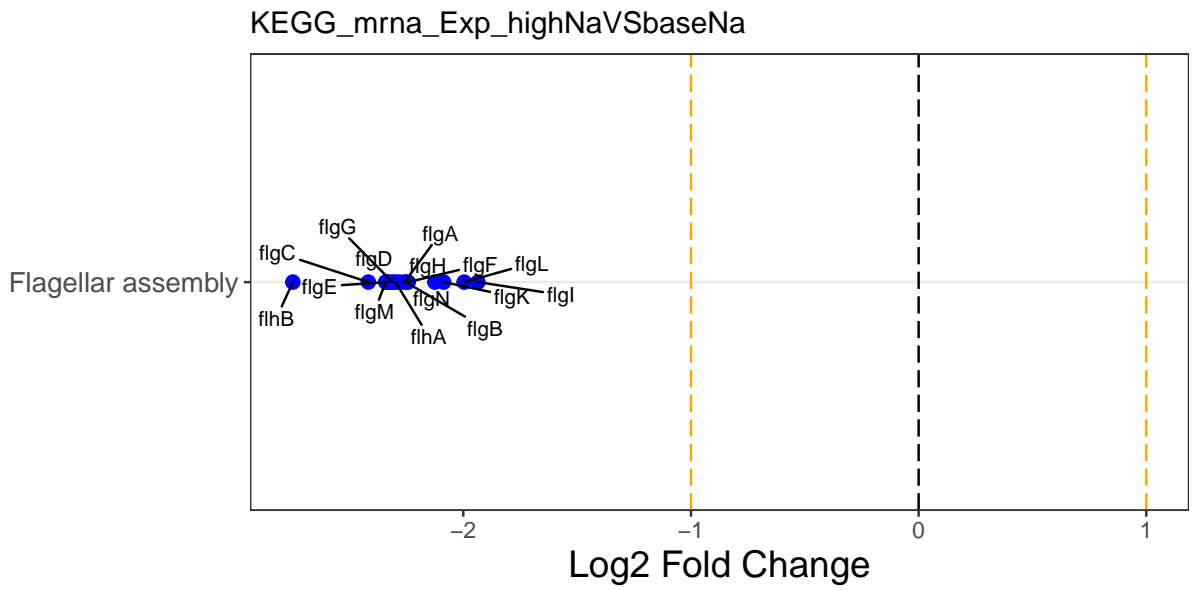


Figure S14: **Significantly differentially expressed KEGG pathway and associated genes with high  $\text{Na}^+$  levels, as determined by mRNA abundances in exponential phase.** The top differentially expressed KEGG pathway is shown along the  $y$  axis, and the relative fold change of the corresponding genes is shown along the  $x$  axis. We show up to 10 of the most significantly changed pathways and for each pathway, we show up to 15 of the most significantly changing genes.

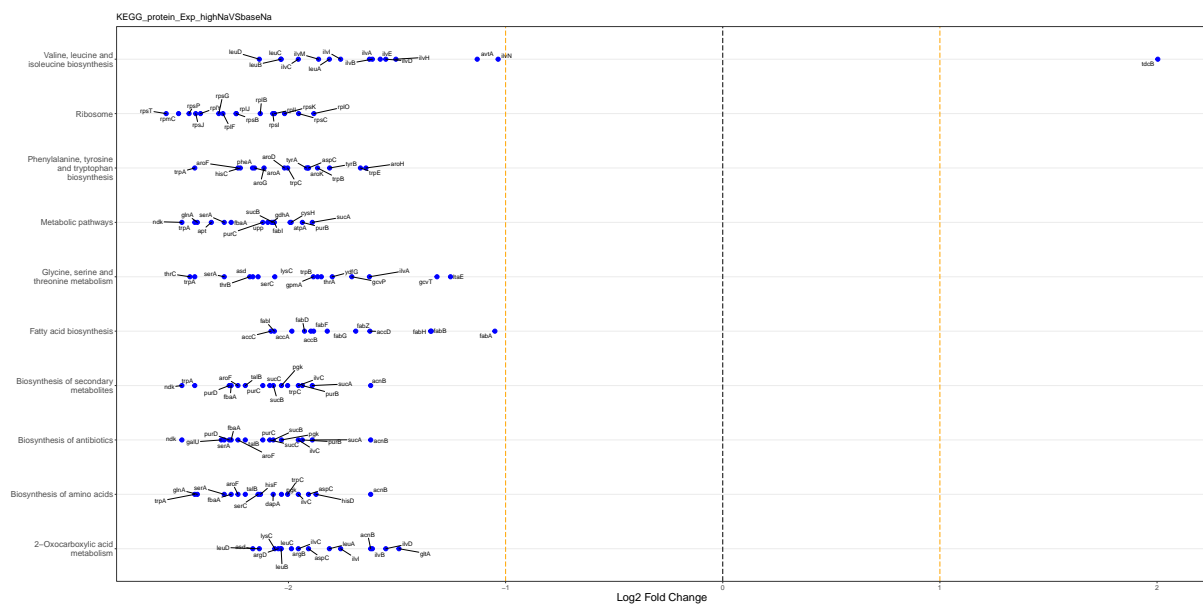


Figure S15: **Significantly differentially expressed KEGG pathways and associated genes with high  $\text{Na}^+$  levels, as determined by protein abundances in exponential phase.** The top 10 differentially expressed KEGG pathways are shown along the  $y$  axis, and the relative fold change of the corresponding genes is shown along the  $x$  axis. We show up to 10 of the most significantly changed pathways and for each pathway, we show up to 15 of the most significantly changing genes.

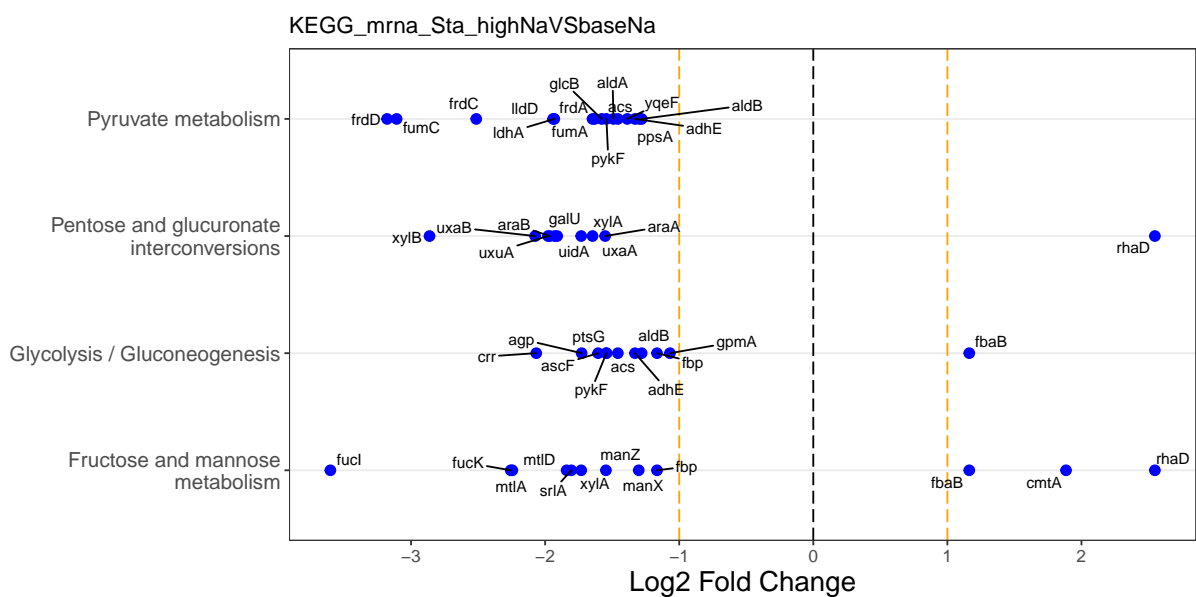


Figure S16: **Significantly differentially expressed KEGG pathways and associated genes with high  $\text{Na}^+$  levels, as determined by mRNA abundances in stationary phase.** The top 4 differentially expressed KEGG pathways are shown along the  $y$  axis, and the relative fold change of the corresponding genes is shown along the  $x$  axis. We show up to 10 of the most significantly changed pathways and for each pathway, we show up to 15 of the most significantly changing genes.

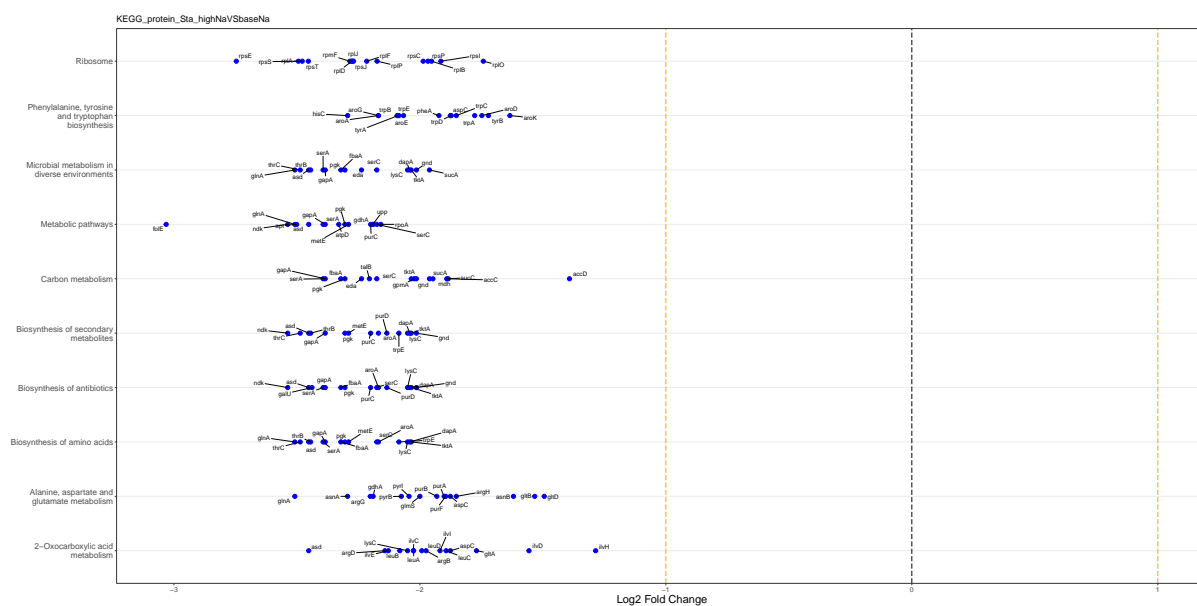


Figure S17: **Significantly differentially expressed KEGG pathways and associated genes with high Na<sup>+</sup> levels, as determined by protein abundances in stationary phase.** The top 10 differentially expressed KEGG pathways are shown along the *y* axis, and the relative fold change of the corresponding genes is shown along the *x* axis. We show up to 10 of the most significantly changed pathways and for each pathway, we show up to 15 of the most significantly changing genes.





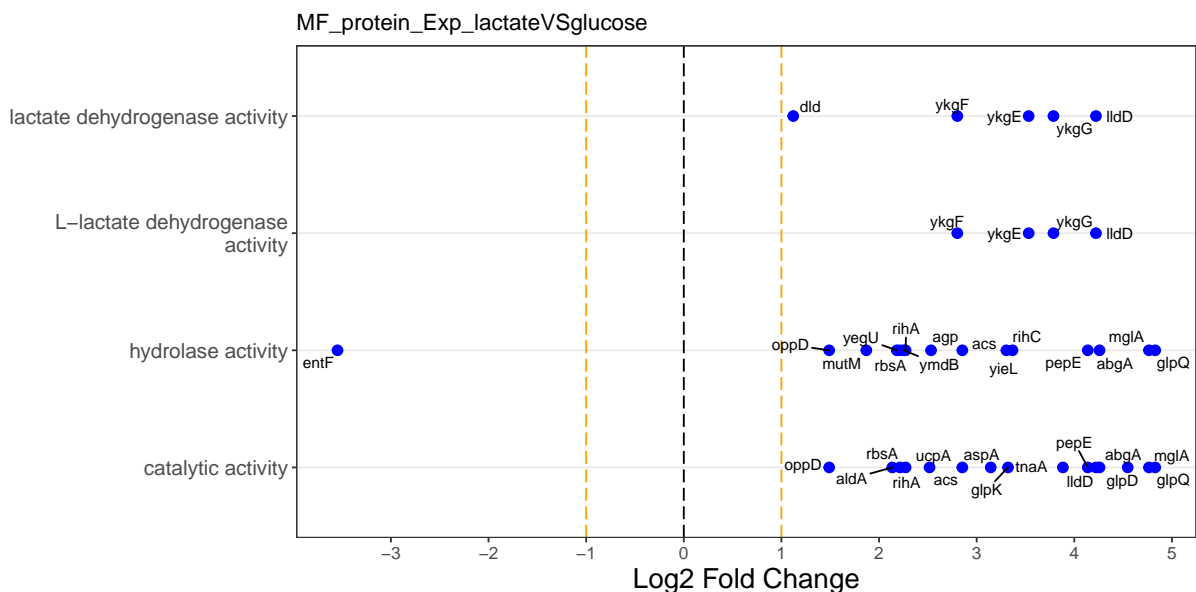


Figure S22: **Significantly differentially expressed GO annotations related with molecular functions and associated genes with lactate as carbon source, as determined by protein abundances in exponential phase.** The top 4 differentially expressed molecular functions are shown along the *y* axis, and the relative fold change of the corresponding genes is shown along the *x* axis. We show up to 10 of the most significantly changed molecular functions and for each molecular function, we show up to 15 of the most significantly changing genes.

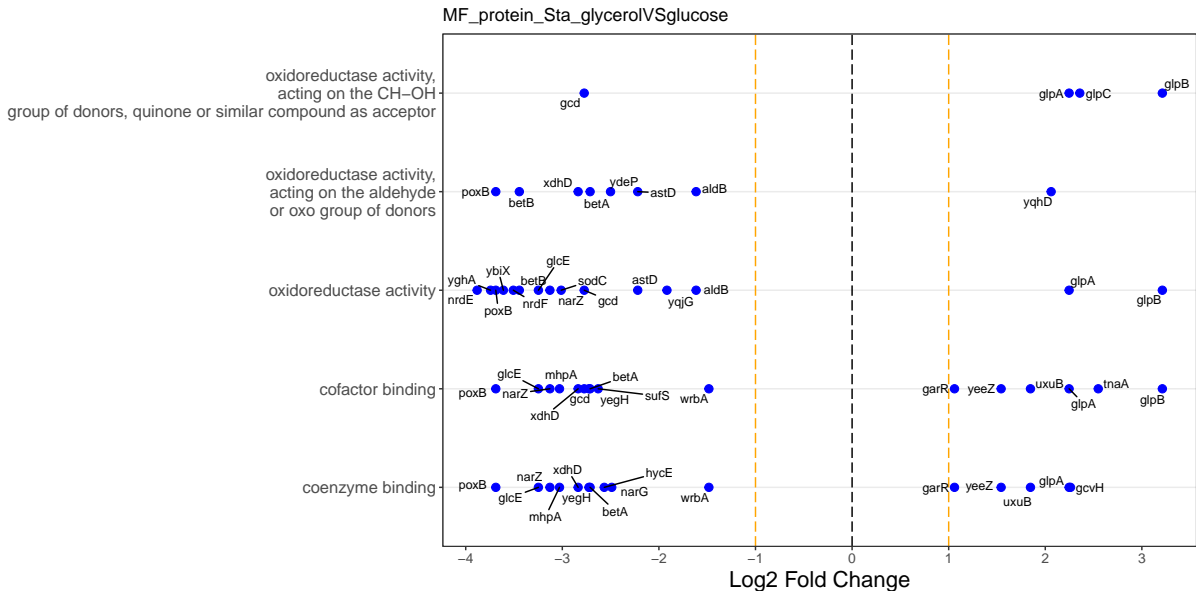


Figure S23: **Significantly differentially expressed GO annotations related with molecular functions and associated genes with glycerol as carbon source, as determined by protein abundances in stationary phase.** The top 5 differentially expressed molecular functions are shown along the *y* axis, and the relative fold change of the corresponding genes is shown along the *x* axis. We show up to 10 of the most significantly changed molecular functions and for each molecular function, we show up to 15 of the most significantly changing genes.

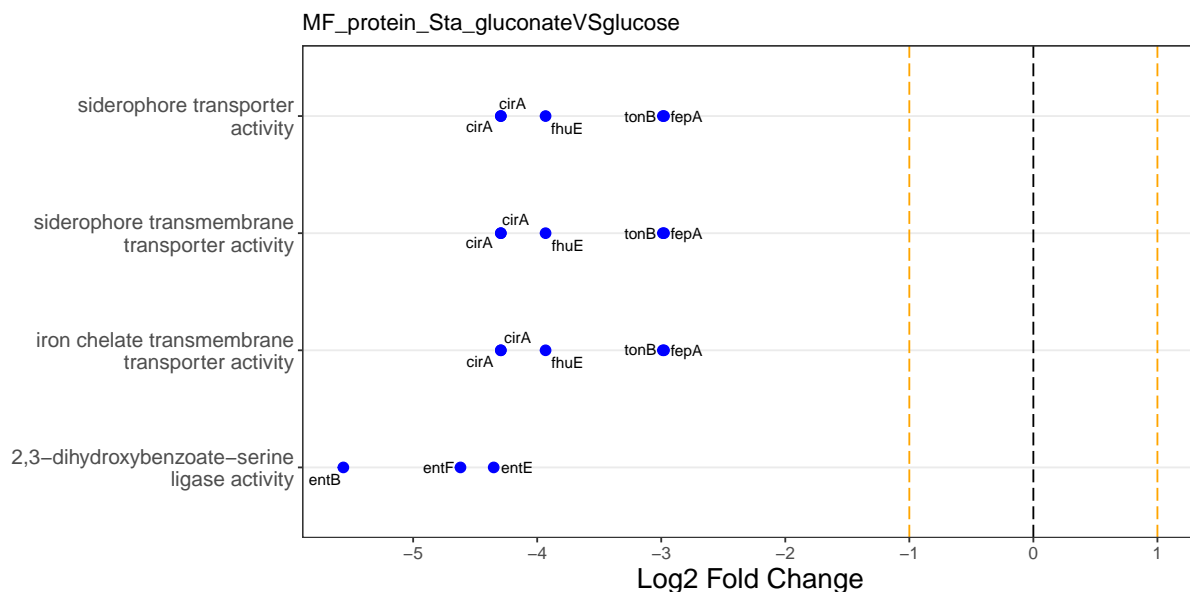


Figure S24: **Significantly differentially expressed GO annotations related with molecular functions and associated genes with gluconate as carbon source, as determined by protein abundances in stationary phase.** The top 4 differentially expressed molecular functions are shown along the *y* axis, and the relative fold change of the corresponding genes is shown along the *x* axis. We show up to 10 of the most significantly changed molecular functions and for each molecular function, we show up to 15 of the most significantly changing genes.

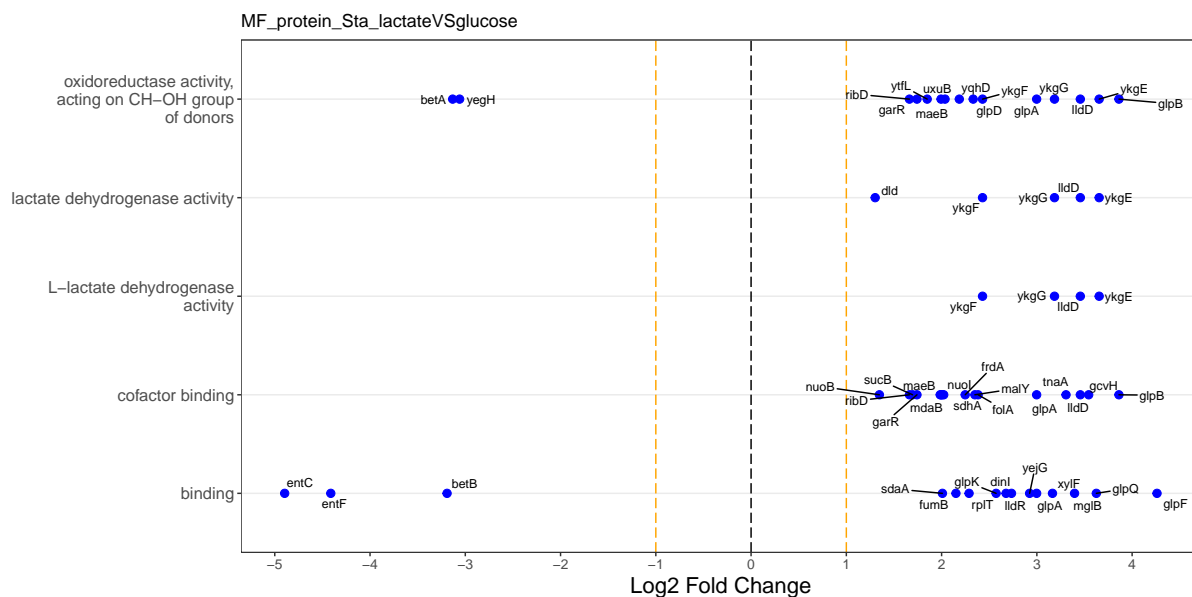


Figure S25: **Significantly differentially expressed GO annotations related with molecular functions and associated genes with lactate as carbon source, as determined by protein abundances in stationary phase.** The top 5 differentially expressed molecular functions are shown along the *y* axis, and the relative fold change of the corresponding genes is shown along the *x* axis. We show up to 10 of the most significantly changed molecular functions and for each molecular function, we show up to 15 of the most significantly changing genes.



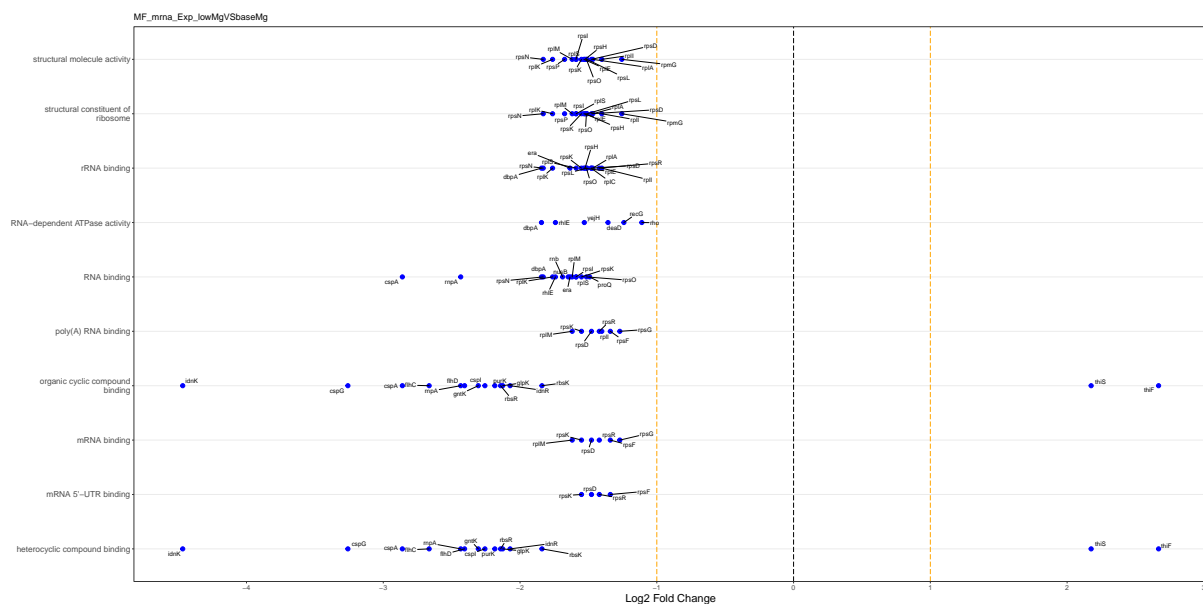


Figure S26: **Significantly differentially expressed GO annotations related with molecular functions and associated genes with low  $Mg^{2+}$  levels, as determined by mRNA abundances in exponential phase.** The top 10 differentially expressed molecular functions are shown along the  $y$  axis, and the relative fold change of the corresponding genes is shown along the  $x$  axis. We show up to 10 of the most significantly changed molecular functions and for each molecular function, we show up to 15 of the most significantly changing genes.

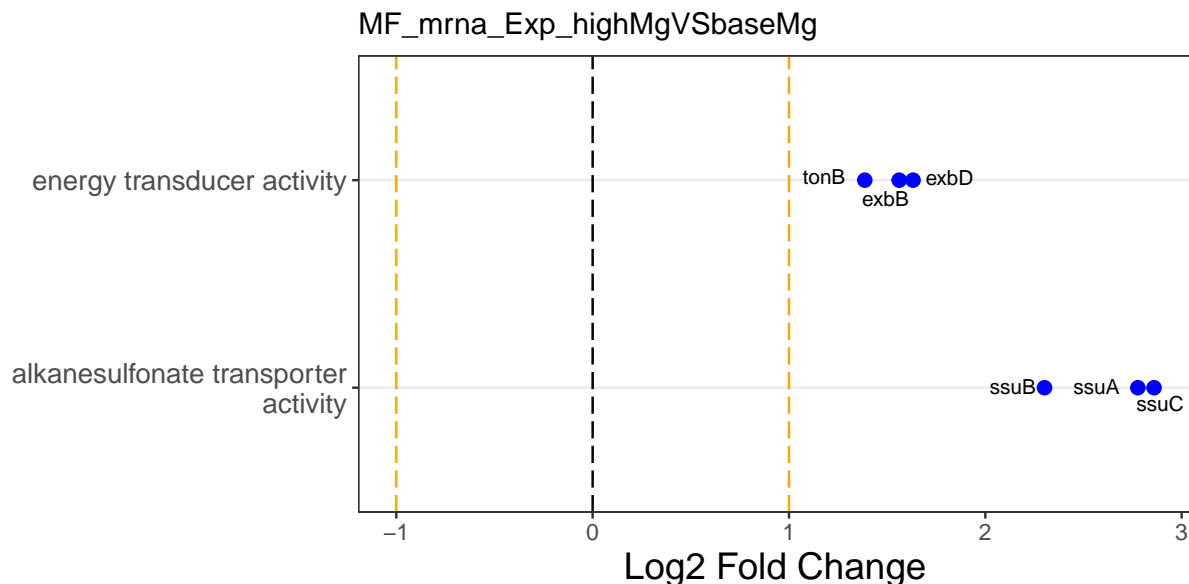


Figure S27: **Significantly differentially expressed GO annotations related with molecular functions and associated genes with high  $Mg^{2+}$  levels, as determined by mRNA abundances in exponential phase.** The top 3 differentially expressed molecular functions are shown along the  $y$  axis, and the relative fold change of the corresponding genes is shown along the  $x$  axis. We show up to 10 of the most significantly changed molecular functions and for each molecular function, we show up to 15 of the most significantly changing genes.

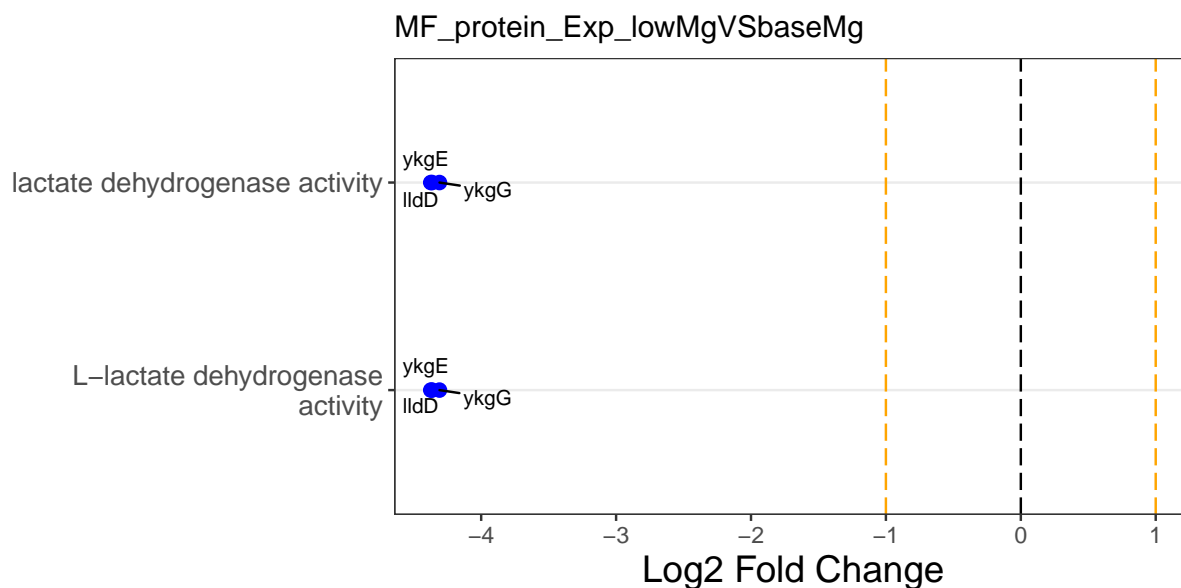


Figure S28: **Significantly differentially expressed GO annotations related with molecular functions and associated genes with low  $Mg^{2+}$  levels, as determined by protein abundances in exponential phase.** The top 2 differentially expressed molecular functions are shown along the  $y$  axis, and the relative fold change of the corresponding genes is shown along the  $x$  axis. We show up to 10 of the most significantly changed molecular functions and for each molecular function, we show up to 15 of the most significantly changing genes.

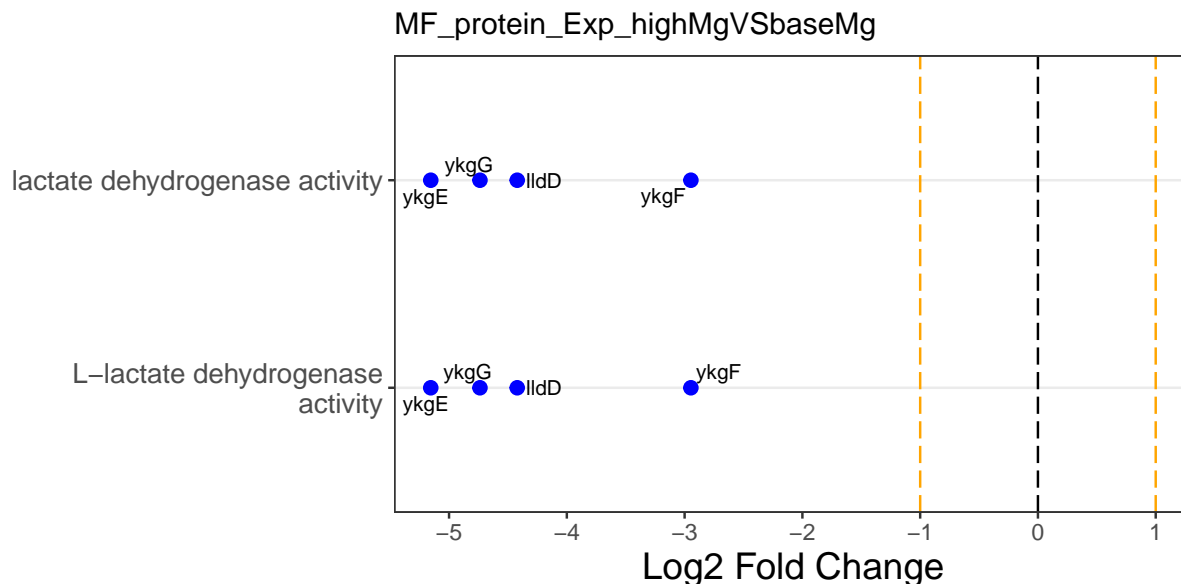


Figure S29: **Significantly differentially expressed GO annotations related with molecular functions and associated genes with high  $Mg^{2+}$  levels, as determined by protein abundances in exponential phase.** The top 2 differentially expressed molecular functions are shown along the  $y$  axis, and the relative fold change of the corresponding genes is shown along the  $x$  axis. We show up to 10 of the most significantly changed molecular functions and for each molecular function, we show up to 15 of the most significantly changing genes.

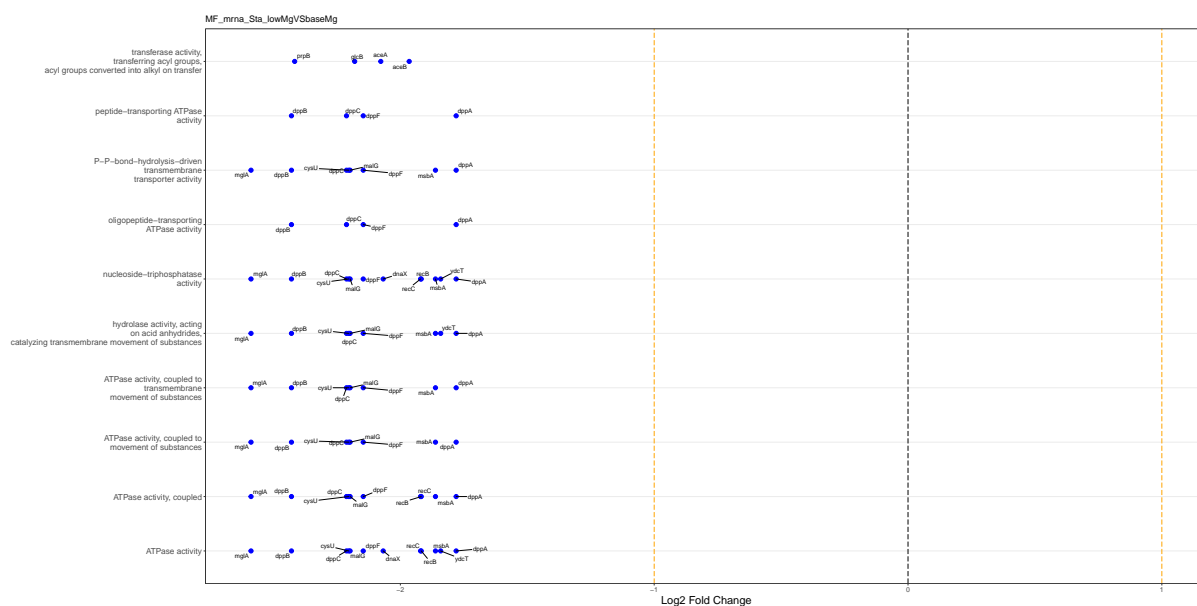


Figure S30: **Significantly differentially expressed GO annotations related with molecular functions and associated genes with low  $Mg^{2+}$  levels, as determined by mRNA abundances in stationary phase.** The top 10 differentially expressed molecular functions are shown along the  $y$  axis, and the relative fold change of the corresponding genes is shown along the  $x$  axis. We show up to 10 of the most significantly changed molecular functions and for each molecular function, we show up to 15 of the most significantly changing genes.

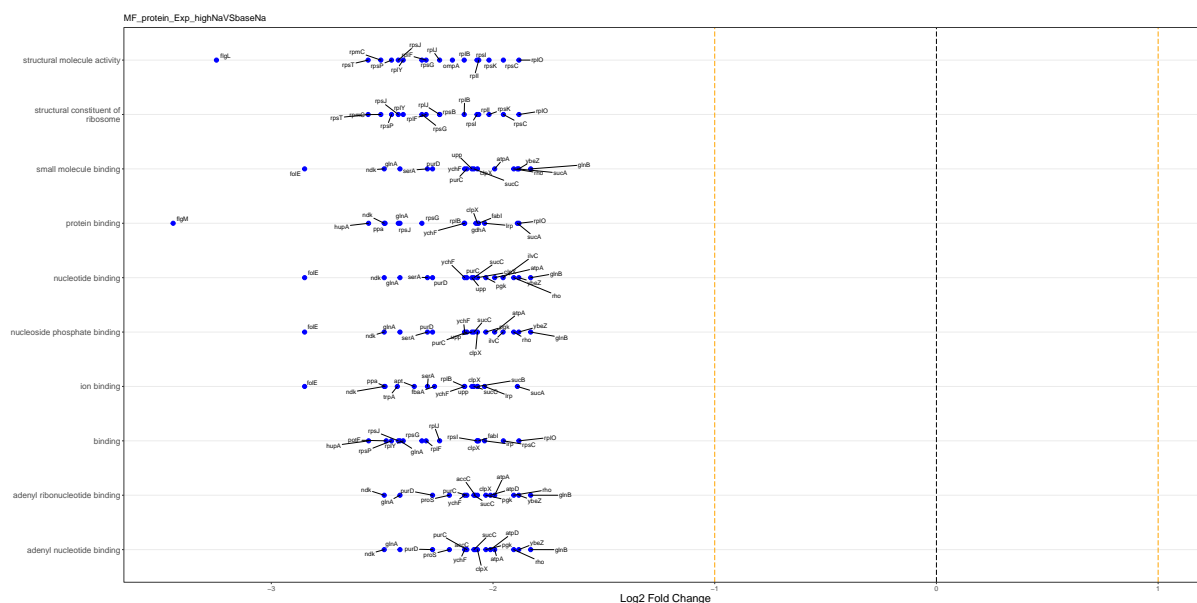


Figure S31: **Significantly differentially expressed GO annotations related with molecular functions and associated genes with high  $Na^{+}$  levels, as determined by protein abundances in exponential phase.** The top differentially expressed molecular functions are shown along the  $y$  axis, and the relative fold change of the corresponding genes is shown along the  $x$  axis. We show up to 10 of the most significantly changed molecular functions and for each molecular function, we show up to 15 of the most significantly changing genes.

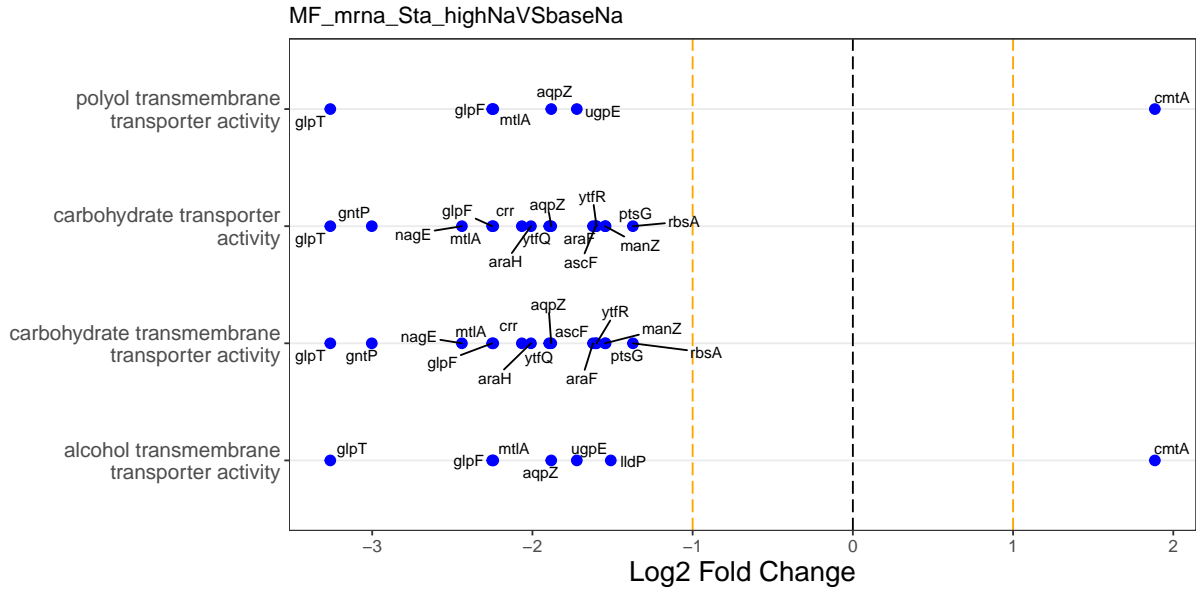


Figure S32: **Significantly differentially expressed GO annotations related with molecular functions and associated genes with high  $\text{Na}^+$  levels, as determined by mRNA abundances in stationary phase.** The top 5 differentially expressed molecular functions are shown along the  $y$  axis, and the relative fold change of the corresponding genes is shown along the  $x$  axis. We show up to 10 of the most significantly changed molecular functions and for each molecular function, we show up to 15 of the most significantly changing genes.

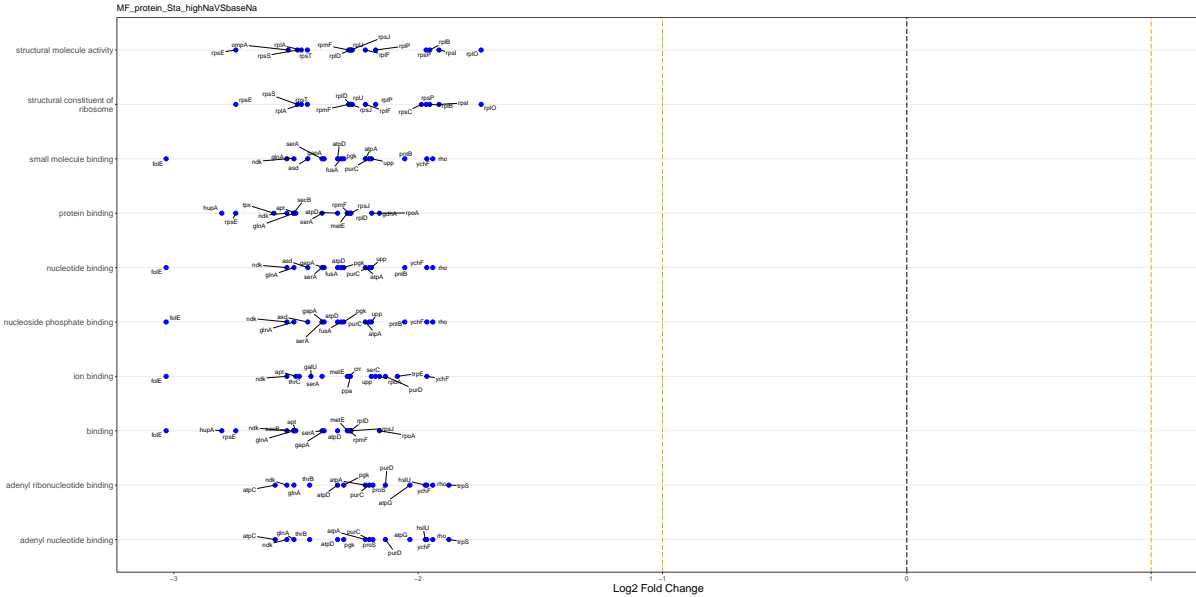


Figure S33: **Significantly differentially expressed GO annotations related with molecular functions and associated genes with high  $\text{Na}^+$  levels, as determined by protein abundances in stationary phase.** The top 10 differentially expressed molecular functions are shown along the  $y$  axis, and the relative fold change of the corresponding genes is shown along the  $x$  axis. We show up to 10 of the most significantly changed molecular functions and for each molecular function, we show up to 15 of the most significantly changing genes.

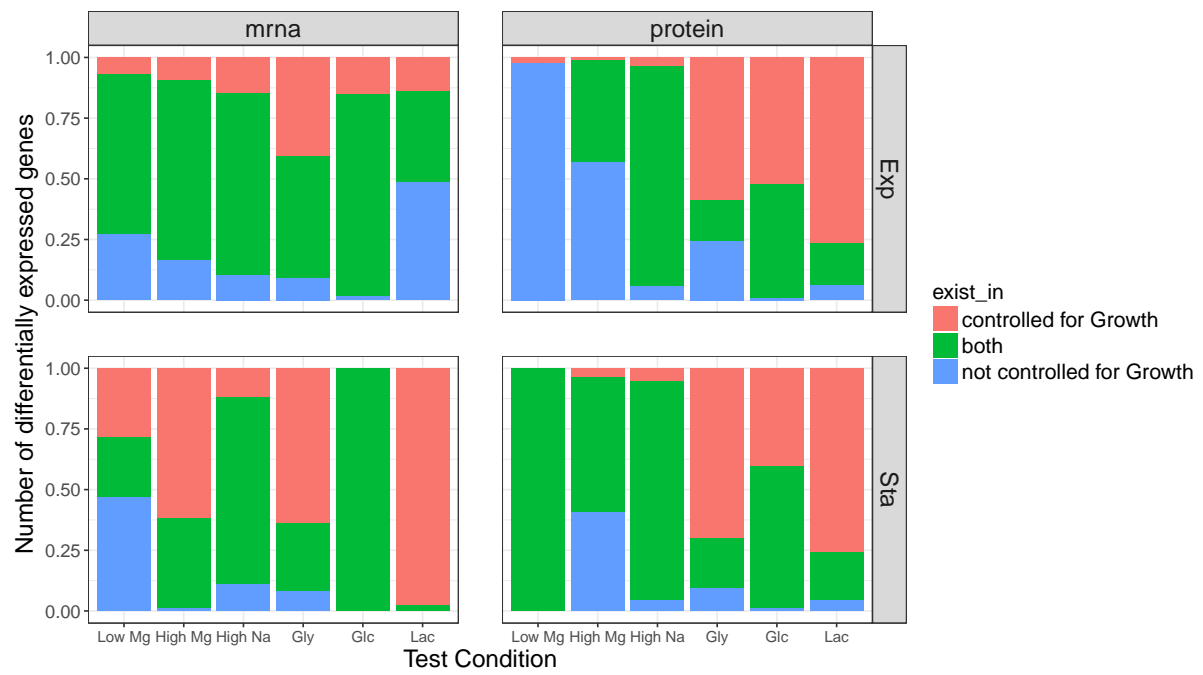


Figure S34: Change in differentially expressed genes between two controls: "batch" vs "batch + growth rate". bla bla.

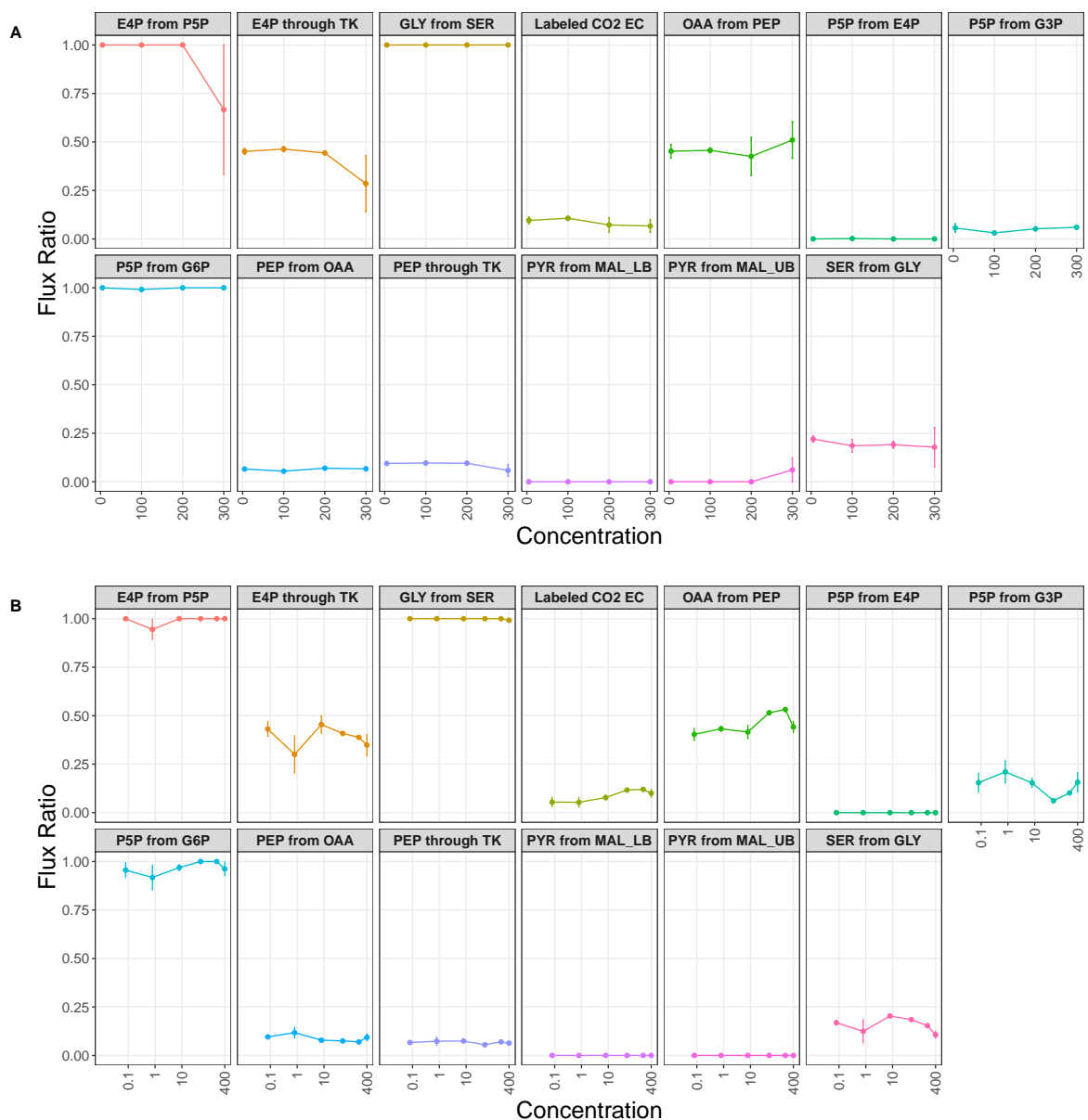


Figure S35: **Flux ratios versus ion concentrations.** 13 different flux ratios were measured with respect to four different Na<sup>+</sup> and five different Mg<sup>2+</sup> concentrations. (A) Concentrations with respect to changing Na<sup>+</sup> concentrations. (B) Concentrations with respect to changing Mg<sup>2+</sup> concentrations. There was no significant trend of increase or decrease in flux ratios with respect to either Na<sup>+</sup> or Mg<sup>2+</sup> concentrations (Supplementary Table 12).