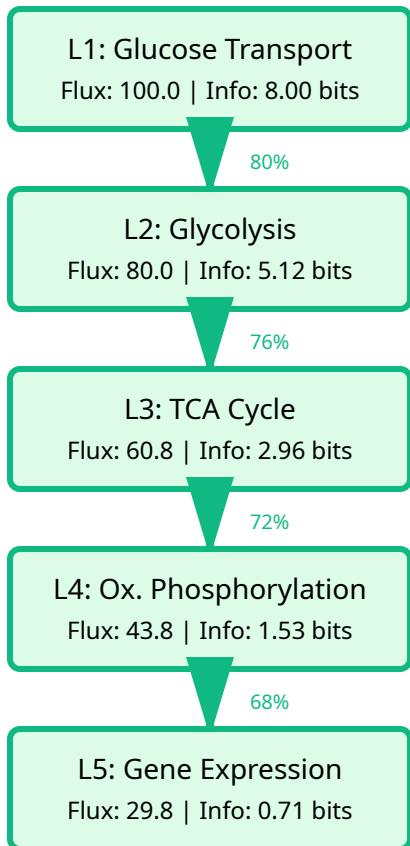
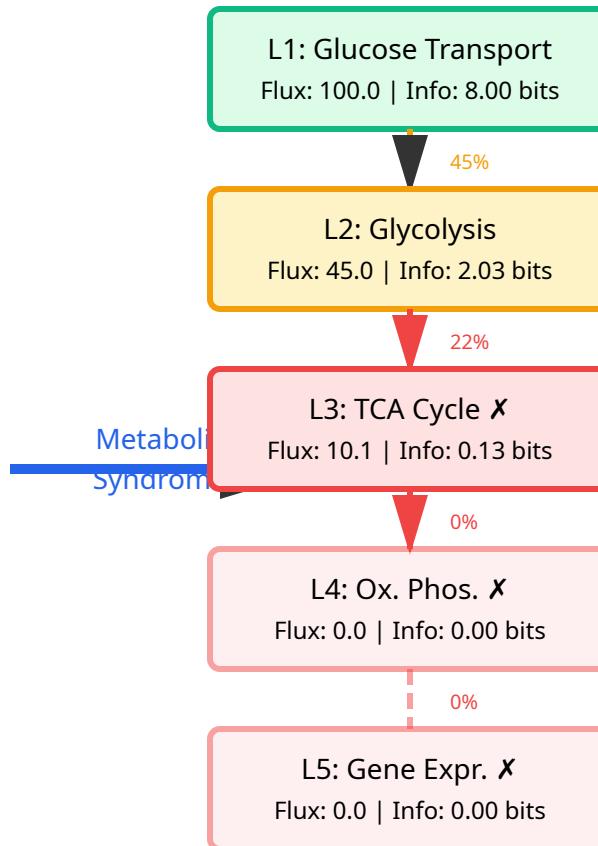


Hierarchical BMD Metabolic Flux Cascade

A. Baseline (Healthy)



B. Metabolic Syndrome (Dysfunction)



Baseline Metrics

Active Levels: **5/5**
 End-to-End Flux: **0.298**
 Total Info: **7.29 bits**
 ATP Efficiency: **4.23 bits/kATP**

Dysfunction Metrics

Active Levels: **2/5**
 End-to-End Flux: **0.000**
 Total Info: **0.13 bits**
 ATP Efficiency: **0.32 bits/kATP**

Hierarchical Information Cascade Failure

Baseline: All 5 levels active with 29.8% end-to-end flux, 7.29 bits total information compression, 4.23 bits/kATP efficiency. Smooth cascade from glucose (100.0 flux) to gene expression (29.8 flux).

Metabolic Syndrome: Cascade failure at L3 (TCA cycle) blocks downstream levels L4-L5, reducing active levels to 2/5, end-to-end flux to 0%, information to 0.13 bits, and efficiency to 0.32 bits/kATP (13x drop).