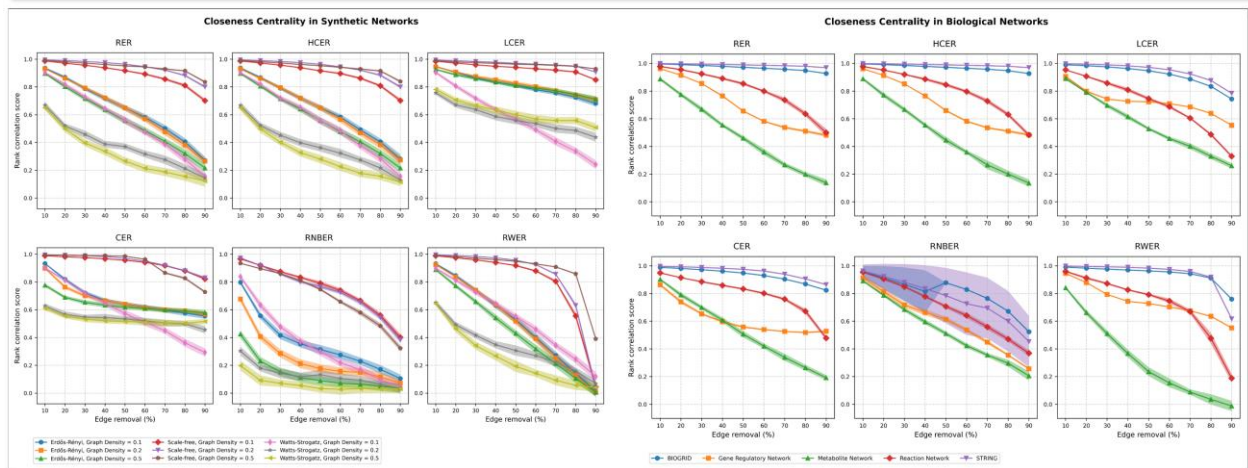
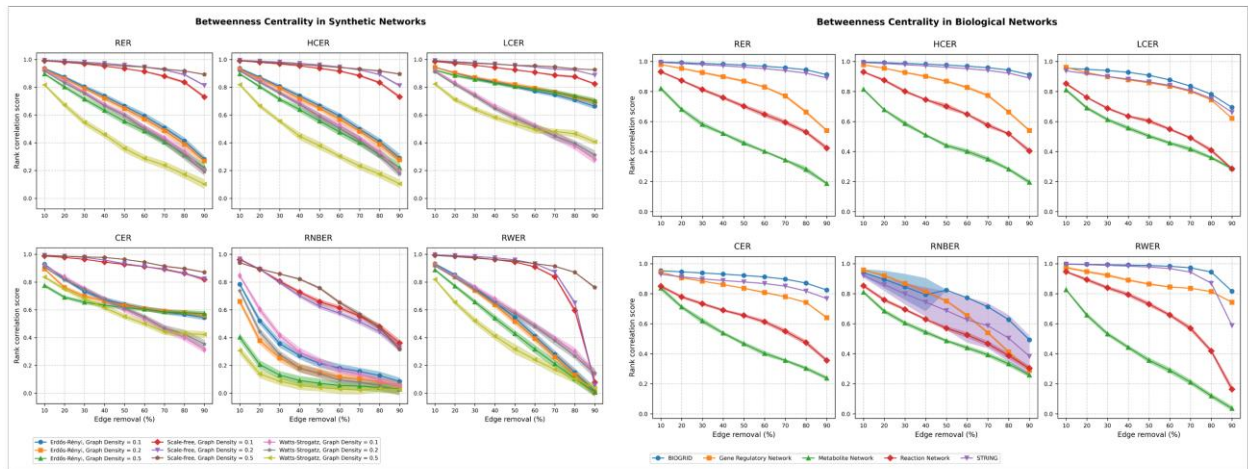
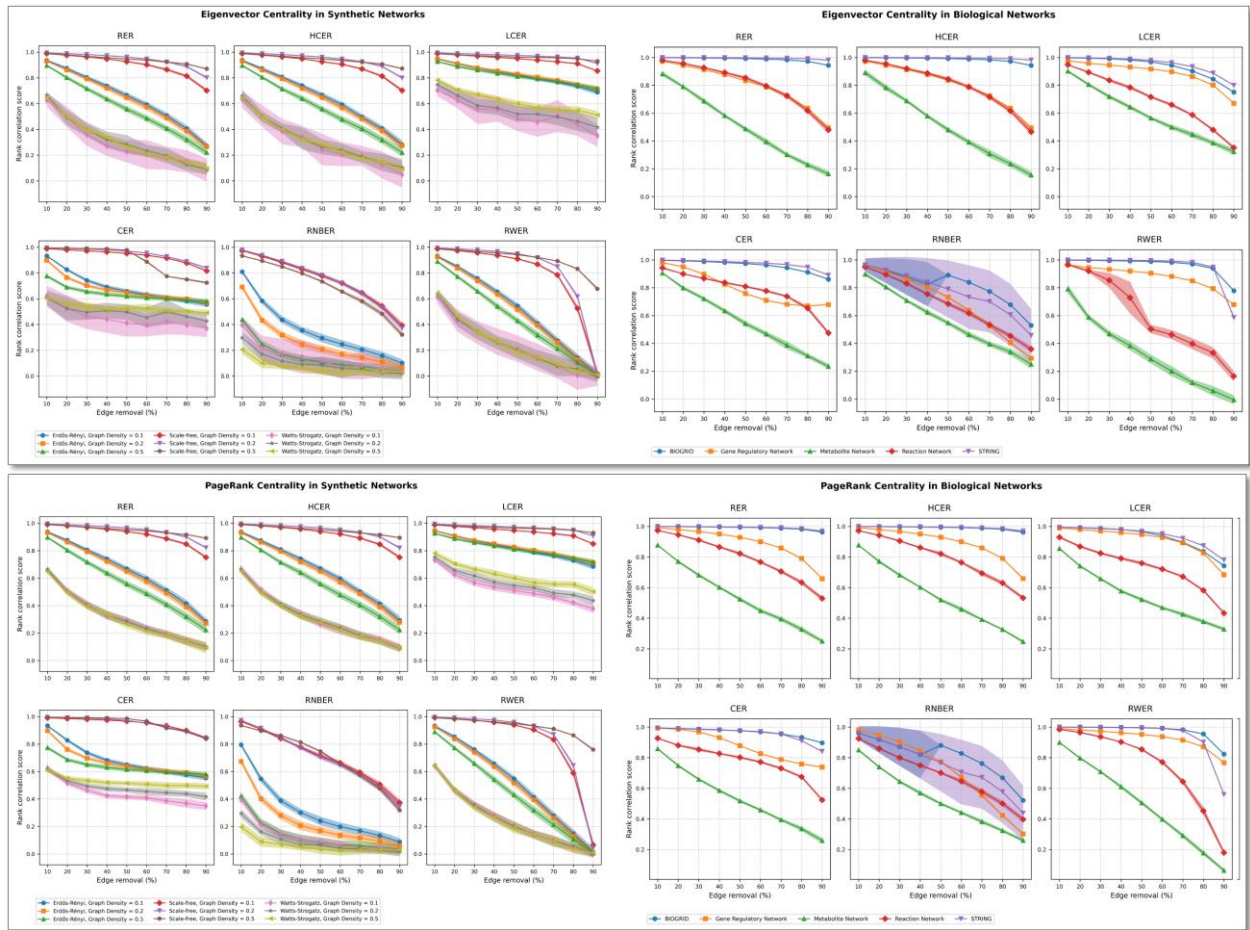
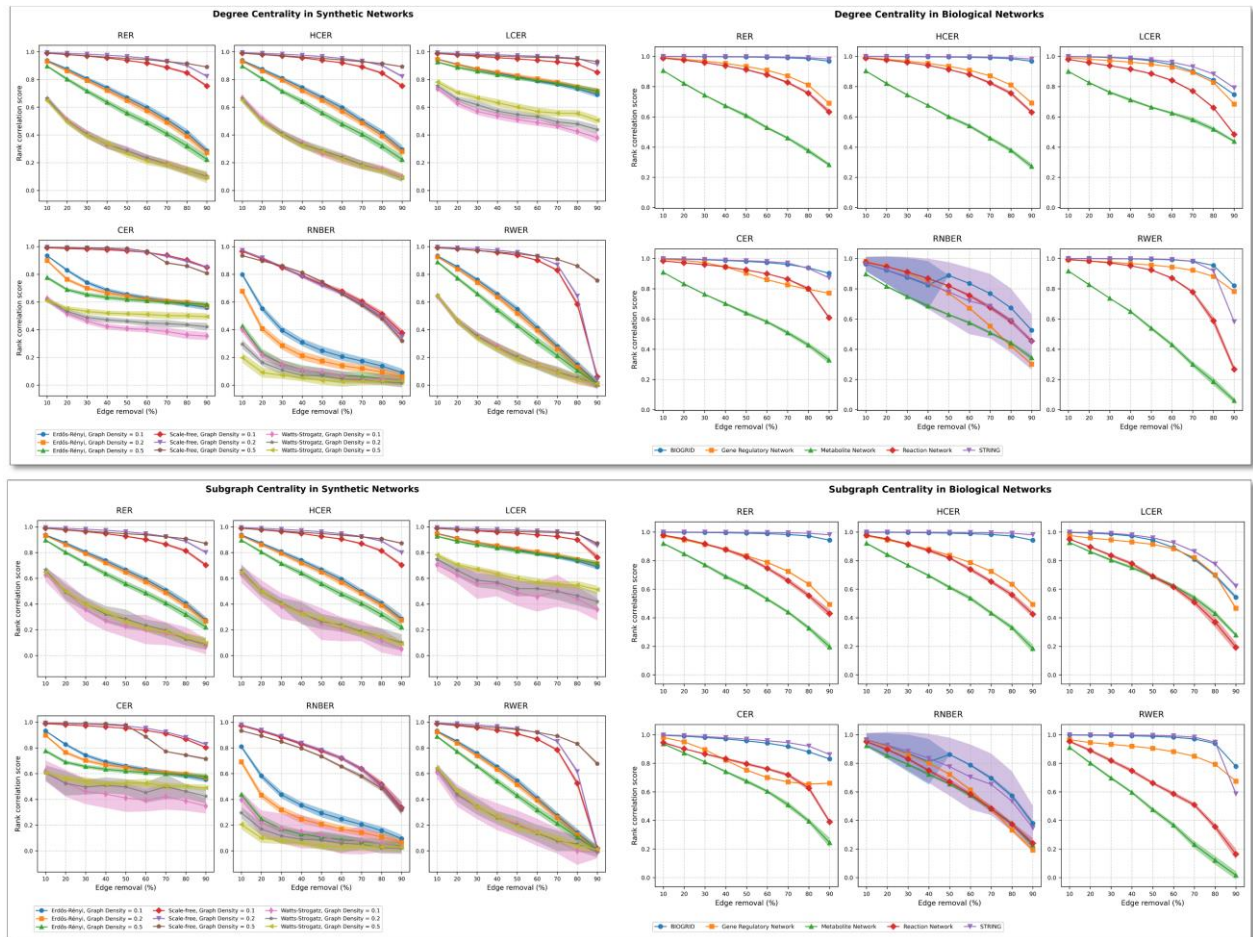


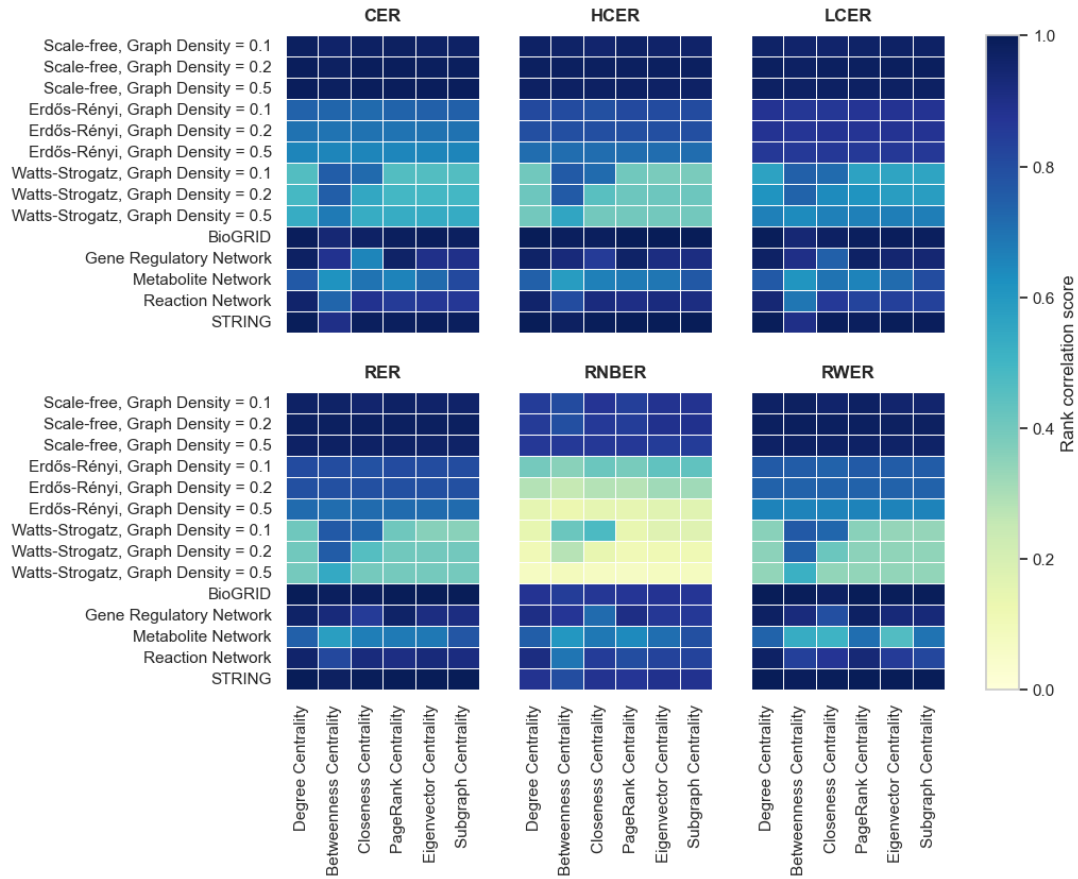




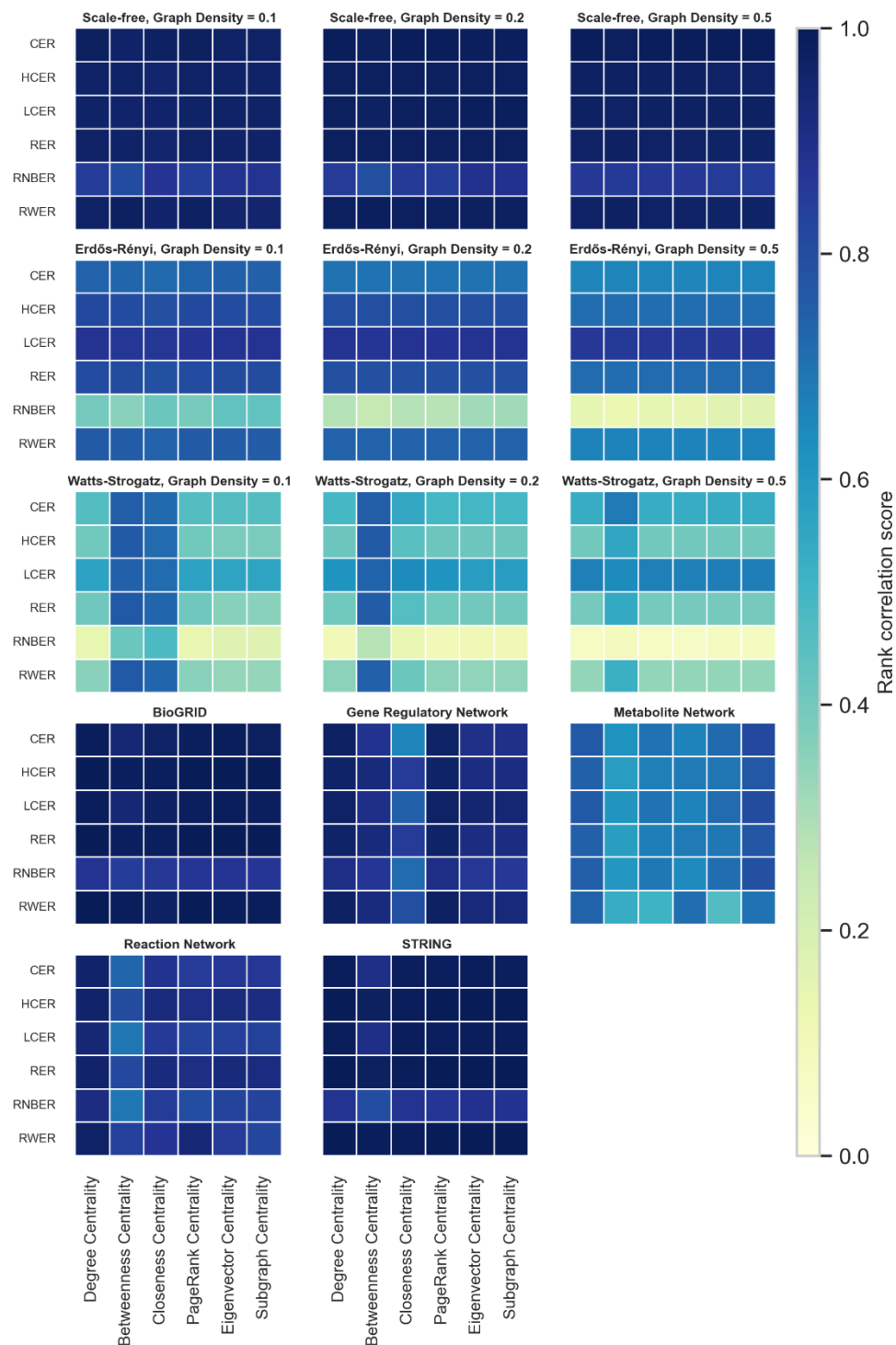


**Supplementary Figure 1. Rank correlation score of all six centrality across different edge removal methods**

Here, we present the results in six panels, each corresponding to a particular centrality measure. To facilitate interpretation, we further divide each panel into two parts, showcasing the results for synthetic and biological networks separately. Within each panel, we illustrate the changes in rank correlation scores under various edge removal scenarios, highlighting the impact of each removal scenario, network structure, network density, and biological network type on these changes.



**Supplementary Figure 2. Heatmap visualization of rank correlation scores for 30% edge removal across various network types and centrality measures**



**Supplementary Figure 3. Heatmap visualization of rank correlation scores for 30% edge removal across various network types and centrality measures**

To simplify interpretation, we generated a heatmap visualization (Supplementary Figure 2 and Supplementary Figure 3) presenting rank correlation scores for 90% edge removal across all cases.

### Supplementary Note 1

This file provides the detailed results of the stable nodes (colored green in Figure 7) analysis performed for each centrality measure under different stochastic edge removal methods. For each method, the stability threshold (defined as the 25th percentile of the standard deviation of ranks) is reported, along with the list of stable nodes. Each stable node is presented with its metabolite name, average rank, and standard deviation of ranks across all perturbation levels. The results are organized by centrality measure (degree, betweenness, closeness, PageRank, eigenvector, and subgraph centrality) and by edge removal method (RER, HCER, LCER, CER, RNBER, RWER).

## STABLE NODES ANALYSIS for RER

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DEGREE CENTRALITY: Stability threshold: 10.471

| Metabolite    | Average Rank | Std Deviation |
|---------------|--------------|---------------|
| sM_glu__L_c   | 2            | 1.25          |
| sM_nh4_c      | 2.89         | 2.47          |
| sM_coa_x      | 4.67         | 4.22          |
| sM_accoa_x    | 5.67         | 2.4           |
| sM_akg_c      | 9.78         | 9.05          |
| sM_gdp_c      | 11.44        | 4.95          |
| sM_gln__L_c   | 13.78        | 4.73          |
| sM_12dgr_SC_c | 19.56        | 8.92          |

BETWEENNESS CENTRALITY: Stability threshold: 18.070

| Metabolite | Average Rank | Std Deviation |
|------------|--------------|---------------|
| sM_akg_c   | 14.78        | 8.31          |

CLOSENESS CENTRALITY: Stability threshold: 167.730

| Metabolite  | Average Rank | Std Deviation |
|-------------|--------------|---------------|
| sM_glu__L_c | 13.89        | 18.59         |
| sM_nh4_c    | 42.22        | 77.28         |
| sM_akg_c    | 43.33        | 27.74         |
| rR_ASPTA    | 66.88        | 47.46         |
| sM_gln__L_c | 68.78        | 59.98         |
| rR_GLUDxi   | 82.88        | 82.21         |
| sM_hdcoa_c  | 162.44       | 128.42        |
| sM_ac_c     | 195.11       | 130.3         |

PAGERANK CENTRALITY: Stability threshold: 200.443

| Metabolite       | Average Rank | Std Deviation |
|------------------|--------------|---------------|
| sM_nh4_c         | 2.11         | 1.85          |
| sM_glu__L_c      | 2.11         | 0.87          |
| sM_coa_x         | 6.22         | 5.49          |
| sM_accoa_x       | 9.33         | 4.67          |
| sM_akg_c         | 10           | 9.48          |
| sM_gdp_c         | 10.67        | 3.89          |
| sM_gln__L_c      | 13.11        | 5.7           |
| sM_pyr_c         | 14.89        | 11.27         |
| sM_12dgr_SC_c    | 20.22        | 8.35          |
| sM_pi_m          | 24.11        | 29.85         |
| sM_malcoa_c      | 28.33        | 32.09         |
| sM_h2o2_c        | 30.22        | 25.11         |
| sM_glu__L_m      | 32.33        | 28.19         |
| sM_atp_x         | 37.44        | 37.41         |
| sM_accoa_m       | 44.44        | 43.98         |
| sM_h_n           | 46.78        | 48.18         |
| sM_h_r           | 54.44        | 30.19         |
| sM_amet_c        | 57.67        | 71.48         |
| sM_hdcea_c       | 61           | 25.04         |
| sM_o2_m          | 102.33       | 74.43         |
| sM_tyr__L_c      | 104.89       | 91.07         |
| sM_dhap_c        | 111.67       | 146.72        |
| sM_for_c         | 112.78       | 149.72        |
| sM_acald_c       | 119.67       | 139.5         |
| rR_ERGSTESTH_SCe | 130.56       | 51.27         |
| sM_3mbald_c      | 132.11       | 56.78         |
| sM_ACP_c         | 156.11       | 96.68         |
| sM_ocdcea_c      | 174.22       | 131.21        |
| rR_AGAT_SC       | 177.78       | 101.53        |
| sM_hdcea_e       | 190          | 98.89         |
| rR_THZPSN1_SC    | 209.78       | 154.41        |
| sM_2phetoh_c     | 215          | 156.96        |
| sM_2mbtoh_c      | 231.56       | 176.66        |
| rR_FECOSTAT_SC   | 404.89       | 194.56        |

EIGENVECTOR CENTRALITY: Stability threshold: 123.001

| Metabolite | Average Rank | Std Deviation |
|------------|--------------|---------------|
| sM_nh4_c   | 72.11        | 106.23        |

SUBGRAPH CENTRALITY: Stability threshold: 130.895

| Metabolite      | Average Rank | Std Deviation |
|-----------------|--------------|---------------|
| sM_glu__L_c     | 2            | 1.25          |
| sM_nh4_c        | 3.89         | 3.07          |
| sM_coa_x        | 4.22         | 4.78          |
| sM_accoa_x      | 6.22         | 2.2           |
| sM_akg_c        | 15           | 20.34         |
| sM_atp_x        | 16.56        | 10.31         |
| sM_gln__L_c     | 18           | 10.89         |
| sM_gdp_c        | 23.44        | 19.55         |
| sM_pyr_c        | 33.67        | 22.34         |
| sM_12dgr_SC_c   | 35           | 17.38         |
| sM_hdcea_c      | 36.22        | 18.16         |
| sM_malcoa_c     | 40.44        | 33.7          |
| sM_accoa_c      | 42.11        | 42.65         |
| sM_amp_x        | 42.33        | 23.08         |
| sM_pmtcoa_c     | 52.78        | 93.03         |
| rR_AGAT_SC      | 53.33        | 46.61         |
| sM_h_n          | 60.44        | 42.95         |
| sM_ocdcea_c     | 64           | 38.04         |
| sM_glu__L_m     | 68.33        | 32.69         |
| sM_h2o2_c       | 71           | 48.94         |
| sM_tdcoa_c      | 72.22        | 121.13        |
| rR_EPISTAT_SC   | 75.44        | 98.24         |
| sM_amet_c       | 80.22        | 71.42         |
| sM_hdcea_e      | 93.11        | 47.33         |
| rR_ERGSTETH_SCe | 95.33        | 36.67         |
| rR_FAO181p_odd  | 101.11       | 49.65         |
| sM_ocdycacoa_c  | 101.33       | 87.37         |
| sM_h_r          | 108.33       | 95.58         |
| rR_FACOAL240p   | 111.33       | 121.52        |
| rR_THZPSN1_SC   | 111.44       | 100.11        |
| sM_f6p_c        | 154.22       | 124.64        |
| rR_GLNS         | 161.11       | 86.04         |
| sM_tyr__L_c     | 171.78       | 116.8         |
| rR_ACACT8p      | 207.89       | 110.13        |

## STABLE NODES ANALYSIS for HCER

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DEGREE CENTRALITY: Stability threshold: 11.829

| Metabolite  | Average Rank | Std Deviation |
|-------------|--------------|---------------|
| sM_nh4_c    | 2            | 0.67          |
| sM_coa_x    | 4.11         | 1.2           |
| sM_glu__L_c | 4.78         | 9.64          |
| sM_akg_c    | 11.22        | 8.15          |
| sM_pyr_c    | 11.78        | 8.32          |
| sM_accoa_c  | 12.78        | 8.66          |
| sM_accoa_x  | 15.89        | 10.68         |
| sM_amet_c   | 19.11        | 8.09          |

BETWEENNESS CENTRALITY: Stability threshold: 62.968

| Metabolite | Average Rank | Std Deviation |
|------------|--------------|---------------|
| sM_coa_x   | 56.89        | 43.84         |

CLOSENESS CENTRALITY: Stability threshold: 127.975

| Metabolite    | Average Rank | Std Deviation |
|---------------|--------------|---------------|
| sM_nh4_c      | 13.22        | 11.34         |
| sM_asp__L_c   | 33.67        | 37.85         |
| rR_GLUdy      | 55           | 69.4          |
| rR_GLUN       | 69.62        | 69.86         |
| rR_IPCS324_SC | 138.78       | 87.84         |
| rR_AGAT_SC    | 151.56       | 97.85         |
| sM_dcacoa_c   | 248.38       | 114.08        |
| sM_gdp_c      | 273.78       | 114.78        |

PAGERANK CENTRALITY: Stability threshold: 301.887

| Metabolite  | Average Rank | Std Deviation |
|-------------|--------------|---------------|
| sM_nh4_c    | 1.67         | 0.82          |
| sM_glu__L_c | 4.33         | 7.67          |
| sM_coa_x    | 5.33         | 2.4           |
| sM_akg_c    | 10.33        | 6.51          |
| sM_accoa_c  | 13.56        | 10.3          |
| sM_pyr_c    | 14.11        | 16.78         |
| sM_amet_c   | 14.67        | 6.16          |
| sM_gdp_c    | 15.33        | 10.07         |

|                 |        |        |
|-----------------|--------|--------|
| sM_12dgr_SC_c   | 19.89  | 11.7   |
| sM_accoa_x      | 24.89  | 20.11  |
| sM_adp_m        | 33     | 33.78  |
| sM_ptd1ino_SC_c | 33.78  | 39.02  |
| sM_atp_x        | 34.78  | 38.55  |
| sM_f6p_c        | 38.22  | 18.44  |
| sM_h2o2_c       | 41.11  | 63.96  |
| sM_pi_m         | 45.22  | 91.32  |
| sM_asp__L_c     | 58.44  | 80.52  |
| sM_ttdca_c      | 58.56  | 28.37  |
| sM_acald_c      | 59.33  | 81.61  |
| sM_ctp_c        | 60.22  | 21.58  |
| sM_gly_c        | 72.33  | 83.02  |
| sM_for_c        | 72.56  | 94.89  |
| rR_PLBP1I_SCe   | 97.33  | 68.36  |
| sM_stcoa_c      | 109.11 | 60.95  |
| sM_pmtcoa_c     | 115.11 | 90.33  |
| sM_ibutoh_c     | 142    | 117.41 |
| sM_cys__L_c     | 159.22 | 187.97 |
| sM_oaa_c        | 177.67 | 200.76 |
| sM_iamoh_c      | 180.67 | 197.72 |
| sM_ocdcea_c     | 193    | 279.77 |
| rR_TAGL_SC      | 253.89 | 215.22 |
| sM_2mppal_c     | 267.44 | 261.34 |
| rR_LPCAT_SC     | 280.89 | 248.86 |
| sM_dadp_c       | 436.89 | 270.19 |

EIGENVECTOR CENTRALITY: Stability threshold: 186.683

| Metabolite | Average Rank | Std Deviation |
|------------|--------------|---------------|
| sM_atp_x   | 255.67       | 180.54        |

SUBGRAPH CENTRALITY: Stability threshold: 199.120

| Metabolite  | Average Rank | Std Deviation |
|-------------|--------------|---------------|
| sM_nh4_c    | 2.11         | 0.74          |
| sM_coa_x    | 4.22         | 1.87          |
| sM_glu__L_c | 9            | 21.57         |
| sM_atp_x    | 16.44        | 13.21         |
| sM_akg_c    | 17.11        | 19.65         |
| sM_pyr_c    | 20.78        | 12.37         |
| sM_gdp_c    | 25.44        | 20.09         |

|                  |        |        |
|------------------|--------|--------|
| sM_ptd1ino_SC_c  | 25.78  | 16.19  |
| sM_12dgr_SC_c    | 29.89  | 24.14  |
| sM_accoa_x       | 31.89  | 26.53  |
| sM_accoa_c       | 34.11  | 27.72  |
| sM_ttdca_c       | 39.67  | 24.51  |
| sM_amet_c        | 40.78  | 26.85  |
| sM_asp__L_c      | 45     | 27.76  |
| rR_GAT2_SC       | 62.56  | 89.4   |
| sM_pi_m          | 75     | 95.44  |
| rR_AGAT_SC       | 75.56  | 102.5  |
| sM_h2o2_c        | 77.78  | 52.07  |
| sM_ocdycocoa_c   | 78.89  | 44.49  |
| rR_PLBP1I_SCe    | 89.89  | 70.08  |
| sM_ocdcea_c      | 95.22  | 83.69  |
| rR_THZPSN2_SC    | 103    | 135.34 |
| rR_FACOAL100p    | 110    | 103.59 |
| sM_ppi_x         | 112.78 | 197.94 |
| sM_hdcea_e       | 115    | 48.38  |
| sM_f6p_c         | 117.56 | 59.53  |
| sM_ctp_c         | 131.56 | 58.75  |
| sM_ddcocoa_c     | 156.22 | 196.58 |
| sM_glycogen_c    | 164.78 | 107.14 |
| rR_ERGSTESTH_SCe | 165.89 | 167.37 |
| sM_acald_c       | 172.44 | 184.07 |
| sM_for_c         | 173    | 113.76 |
| sM_hcys__L_c     | 186.78 | 131.56 |
| rR_IPCS324_SC    | 226.22 | 149.93 |

## STABLE NODES ANALYSIS for LCER

=====

DEGREE CENTRALITY: Stability threshold: 3.991

| Metabolite  | Average Rank | Std Deviation |
|-------------|--------------|---------------|
| sM_glu__L_c | 1.56         | 0.5           |
| sM_nh4_c    | 3            | 1.15          |
| sM_coa_x    | 3.56         | 0.5           |
| sM_akg_c    | 6.44         | 2.75          |
| sM_pmtcoa_c | 13           | 3.65          |

BETWEENNESS CENTRALITY: Stability threshold: 38.041

| Metabolite  | Average Rank | Std Deviation |
|-------------|--------------|---------------|
| sM_glu__L_c | 2.67         | 1.89          |
| sM_atp_x    | 26.22        | 22.97         |

CLOSENESS CENTRALITY: Stability threshold: 9.740

| Metabolite  | Average Rank | Std Deviation |
|-------------|--------------|---------------|
| sM_glu__L_c | 2.33         | 0.94          |
| sM_asp__L_c | 7.44         | 4.17          |
| sM_gln__L_c | 8.78         | 4.08          |
| sM_met__L_c | 15.78        | 2.1           |
| sM_pe_SC_c  | 25.67        | 8.72          |

PAGERANK CENTRALITY: Stability threshold: 34.250

| Metabolite    | Average Rank | Std Deviation |
|---------------|--------------|---------------|
| sM_glu__L_c   | 1.78         | 0.42          |
| sM_nh4_c      | 2.33         | 1.05          |
| sM_coa_x      | 3.89         | 0.31          |
| sM_akg_c      | 6.11         | 1.85          |
| sM_gdp_c      | 10.22        | 5.77          |
| sM_pyr_c      | 10.56        | 4.62          |
| sM_12dgr_SC_c | 13.89        | 5.7           |
| sM_amet_c     | 15           | 4.4           |
| sM_accoa_x    | 15.67        | 8.56          |
| sM_atp_x      | 20.33        | 9.09          |
| sM_accoa_c    | 20.56        | 33.05         |
| sM_malcoa_c   | 20.78        | 8.38          |
| sM_pi_m       | 21.33        | 19.91         |

|                 |        |       |
|-----------------|--------|-------|
| sM_h2o2_c       | 24.44  | 13.17 |
| sM_glu__L_m     | 25.78  | 32.66 |
| sM_ptd1ino_SC_c | 27.56  | 22.18 |
| sM_ac_c         | 30.89  | 21.53 |
| sM_ACP_m        | 32.33  | 12.23 |
| sM_pmtcoa_c     | 37.33  | 8.93  |
| sM_tdcoa_c      | 40     | 12.06 |
| sM_gly_c        | 44.33  | 31.22 |
| sM_ser__L_c     | 44.67  | 32.87 |
| sM_ahcys_c      | 45.78  | 31.1  |
| sM_utp_c        | 46     | 11.13 |
| sM_trdrd_c      | 48.89  | 17.37 |
| sM_cys__L_c     | 51.67  | 26.76 |
| sM_ttdca_c      | 52     | 22.18 |
| sM_succ_c       | 55.33  | 16.21 |
| sM_odecoa_c     | 59     | 24.23 |
| sM_atp_n        | 72.78  | 29.14 |
| sM_hdcea_c      | 74.89  | 26.98 |
| rR_PLBPC_SC     | 87.33  | 32.02 |
| rR_GAT2_SC      | 110.22 | 32.35 |
| rR_TRIGS_SC     | 134    | 28.43 |

EIGENVECTOR CENTRALITY: Stability threshold: 2.362

| Metabolite  | Average Rank | Std Deviation |
|-------------|--------------|---------------|
| sM_tdcoa_c  | 3.56         | 1.64          |
| sM_pmtcoa_c | 3.89         | 2.23          |
| rR_TRIGS_SC | 11.22        | 1.69          |

SUBGRAPH CENTRALITY: Stability threshold: 25.830

| Metabolite  | Average Rank | Std Deviation |
|-------------|--------------|---------------|
| sM_glu__L_c | 1.44         | 0.5           |
| sM_coa_x    | 3.33         | 1.89          |
| sM_tdcoa_c  | 5.78         | 1.23          |
| sM_nh4_c    | 6            | 3.23          |
| sM_pmtcoa_c | 6.56         | 2.83          |
| sM_hdcoa_c  | 9.56         | 4.03          |
| sM_stcoa_c  | 10           | 3.4           |
| sM_odecoa_c | 10.11        | 5.72          |
| rR_GAT1_SC  | 11           | 3.89          |
| rR_GAT2_SC  | 13.22        | 2.1           |

|                  |        |       |
|------------------|--------|-------|
| rR_LPCAT_SC      | 13.33  | 2.62  |
| rR_TRIGS_SC      | 15.11  | 2.13  |
| sM_akg_c         | 15.33  | 7.18  |
| sM_atp_x         | 16.44  | 7.26  |
| rR_AGAT_SC       | 17.56  | 17.05 |
| sM_accoa_x       | 21.67  | 13.79 |
| rR_ZYMSTAT_SC    | 23.11  | 5.17  |
| rR_LANOSTAT_SC   | 23.56  | 6.93  |
| sM_gln__L_c      | 25     | 15.08 |
| rR_FECOSTAT_SC   | 26.33  | 19.09 |
| rR_EPISTAT_SC    | 26.67  | 21.43 |
| sM_ocdycacoa_c   | 26.89  | 6.82  |
| sM_ttdca_c       | 32.33  | 10.12 |
| sM_12dgr_SC_c    | 35.44  | 8.47  |
| sM_hdca_c        | 36.22  | 17.07 |
| sM_asp__L_c      | 37.22  | 17.17 |
| sM_gdp_c         | 39.67  | 18.51 |
| sM_pyr_c         | 41.11  | 14.61 |
| sM_ptd1ino_SC_c  | 46.56  | 18.73 |
| sM_ocdca_e       | 61.67  | 21.98 |
| rR_FECOSTESTH_SC | 64.78  | 22.3  |
| sM_amet_c        | 75.67  | 20.2  |
| sM_met__L_c      | 102.33 | 23.62 |
| sM_h2o2_c        | 120    | 17.32 |

## STABLE NODES ANALYSIS for CER

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DEGREE CENTRALITY: Stability threshold: 6.652

| Metabolite  | Average Rank | Std Deviation |
|-------------|--------------|---------------|
| sM_glu__L_c | 1.56         | 0.83          |
| sM_nh4_c    | 2.22         | 1.03          |
| sM_coa_x    | 3.78         | 0.42          |
| sM_accoa_x  | 7.11         | 1.45          |
| sM_pyr_c    | 9.44         | 1.83          |
| sM_malcoa_c | 11.22        | 3.99          |
| sM_tdcoa_c  | 14.78        | 6.01          |

BETWEENNESS CENTRALITY: Stability threshold: 12.372

| Metabolite  | Average Rank | Std Deviation |
|-------------|--------------|---------------|
| sM_glu__L_c | 2.44         | 1.07          |
| sM_coa_x    | 20.22        | 11.84         |

CLOSENESS CENTRALITY: Stability threshold: 27.689

| Metabolite  | Average Rank | Std Deviation |
|-------------|--------------|---------------|
| sM_glu__L_c | 2.11         | 0.74          |
| sM_gln__L_c | 17           | 19.11         |
| sM_leu__L_c | 30.89        | 11.28         |
| rR_VALTA    | 50.56        | 21.86         |
| rR_EHGLAT   | 52.33        | 17.33         |
| rR_GLU5K    | 67.38        | 26.8          |
| rR_GLUTRS   | 67.67        | 26.86         |

PAGERANK CENTRALITY: Stability threshold: 149.741

| Metabolite      | Average Rank | Std Deviation |
|-----------------|--------------|---------------|
| sM_nh4_c        | 1.67         | 0.67          |
| sM_glu__L_c     | 1.89         | 0.87          |
| sM_coa_x        | 4.22         | 0.42          |
| sM_pyr_c        | 9            | 2.21          |
| sM_accoa_x      | 12           | 3.86          |
| sM_accoa_c      | 12.44        | 18.26         |
| sM_malcoa_c     | 15.22        | 6.73          |
| sM_12dgr_SC_c   | 18.78        | 7.28          |
| sM_ptd1ino_SC_c | 21.44        | 12.45         |

|                  |        |        |
|------------------|--------|--------|
| sM_h_n           | 23     | 7.94   |
| sM_atp_x         | 24.11  | 11.01  |
| sM_gtp_c         | 27.78  | 11.49  |
| sM_gln__L_c      | 29.22  | 41.61  |
| sM_ahcys_c       | 31.22  | 15.75  |
| sM_tdcoa_c       | 34     | 14.04  |
| sM_asp__L_c      | 34.11  | 40.55  |
| sM_h2o2_c        | 34.33  | 27     |
| sM_gly_c         | 34.44  | 18.82  |
| sM_glu__L_m      | 42.11  | 56.97  |
| sM_utp_c         | 60.44  | 62.57  |
| sM_acald_c       | 71.67  | 96.96  |
| rR_THZPSN1_SC    | 79.78  | 38.01  |
| sM_ocdca_c       | 83.33  | 52.89  |
| sM_malACP_m      | 88.33  | 71.74  |
| rR_PLBP1I_SCe    | 91.33  | 51.78  |
| sM_adp_n         | 93.67  | 40.03  |
| sM_r5p_c         | 106.22 | 102.91 |
| sM_gdpmann_c     | 114.22 | 65.35  |
| sM_o2_m          | 124.67 | 143.61 |
| sM_fum_c         | 129.44 | 100.56 |
| sM_q6h2_m        | 139.89 | 101.55 |
| rR_EPISTESTH_SC  | 154.67 | 84.29  |
| rR_LPCAT_SC      | 177.56 | 107.4  |
| rR_EPISTESTH_SCe | 189    | 137.13 |

EIGENVECTOR CENTRALITY: Stability threshold: 26.888

| Metabolite  | Average Rank | Std Deviation |
|-------------|--------------|---------------|
| sM_glu__L_c | 1.11         | 0.31          |
| rR_GLU5K    | 42.62        | 18.53         |

SUBGRAPH CENTRALITY: Stability threshold: 66.279

| Metabolite  | Average Rank | Std Deviation |
|-------------|--------------|---------------|
| sM_glu__L_c | 1.33         | 0.67          |
| sM_coa_x    | 3.11         | 0.87          |
| sM_nh4_c    | 3.56         | 0.68          |
| sM_accoa_x  | 8.89         | 4.93          |
| sM_tdcoa_c  | 9.44         | 3.56          |
| sM_gln__L_c | 16.67        | 6.07          |
| sM_atp_x    | 19.78        | 21.18         |

|                 |        |       |
|-----------------|--------|-------|
| sM_pyr_c        | 24.11  | 12.49 |
| sM_akg_c        | 24.11  | 35.41 |
| rR_AGAT_SC      | 30.22  | 26.04 |
| sM_stcoa_c      | 33.89  | 52.72 |
| sM_hdcoa_c      | 35.56  | 52.59 |
| sM_asp__L_c     | 37.11  | 25.6  |
| sM_malcoa_c     | 37.89  | 24.92 |
| sM_accoa_c      | 39.22  | 36.81 |
| sM_12dgr_SC_c   | 39.89  | 17.76 |
| sM_hdca_c       | 49.44  | 35.72 |
| rR_LPCAT_SC     | 51.22  | 59.85 |
| sM_gly_c        | 54.56  | 37.33 |
| rR_LANOSTAT_SC  | 55.11  | 43.52 |
| rR_THZPSN1_SC   | 61.67  | 33.47 |
| sM_ocdca_c      | 70.11  | 48.71 |
| rR_FACOAL141p   | 71.78  | 33.87 |
| sM_cys__L_c     | 74.44  | 39.73 |
| sM_h_r          | 81     | 36.39 |
| rR_EPISTESTH_SC | 82.22  | 31.48 |
| rR_TAGL_SC      | 87.11  | 48.14 |
| rR_EHGLAT       | 92.56  | 31.12 |
| sM_h2o2_c       | 105.44 | 49.52 |
| sM_leu__L_c     | 105.89 | 46.3  |
| sM_ocdycacoa_c  | 110.56 | 63.54 |
| sM_ump_c        | 125.44 | 63.34 |
| sM_adp_n        | 161.89 | 47.94 |
| rR_DCMPDA       | 184.11 | 61.88 |

## STABLE NODES ANALYSIS for RNBER

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DEGREE CENTRALITY: Stability threshold: 4.955

| Metabolite  | Average Rank | Std Deviation |
|-------------|--------------|---------------|
| sM_nh4_c    | 2.44         | 1.34          |
| sM_glu__L_c | 2.56         | 1.89          |
| sM_coa_x    | 4.22         | 2.94          |
| sM_akg_c    | 7.67         | 4.88          |
| sM_accoa_x  | 8.67         | 3.71          |
| sM_gdp_c    | 11.44        | 4.14          |

BETWEENNESS CENTRALITY: Stability threshold: 26.476

| Metabolite  | Average Rank | Std Deviation |
|-------------|--------------|---------------|
| sM_glu__L_c | 2.89         | 2.51          |
| sM_atp_x    | 24.33        | 13.54         |

CLOSENESS CENTRALITY: Stability threshold: 27.579

| Metabolite  | Average Rank | Std Deviation |
|-------------|--------------|---------------|
| sM_glu__L_c | 9.11         | 14.28         |
| sM_tyr__L_c | 24.11        | 10.08         |
| sM_tre_c    | 30.71        | 10.31         |
| sM_dtmp_c   | 35.5         | 12.04         |
| rR_TYRTAi   | 51.62        | 19.96         |
| rR_GLUCYS   | 56.71        | 25.87         |

PAGERANK CENTRALITY: Stability threshold: 159.274

| Metabolite  | Average Rank | Std Deviation |
|-------------|--------------|---------------|
| sM_nh4_c    | 1.89         | 0.74          |
| sM_glu__L_c | 2.33         | 1.25          |
| sM_coa_x    | 5.22         | 3.97          |
| sM_akg_c    | 6.33         | 2.11          |
| sM_accoa_c  | 9.33         | 5.4           |
| sM_gdp_c    | 10.11        | 3.28          |
| sM_accoa_x  | 14.56        | 5.56          |
| sM_glu__L_m | 15.67        | 8.81          |
| sM_malcoa_c | 18           | 6.98          |
| sM_pyr_c    | 23.56        | 24.6          |
| sM_ac_c     | 27.89        | 23.12         |

|                |        |        |
|----------------|--------|--------|
| sM_ahcys_c     | 28.22  | 23.77  |
| sM_atp_x       | 30.78  | 14.31  |
| sM_h2o2_c      | 32.22  | 24.3   |
| sM_ttdca_c     | 39.33  | 19.74  |
| sM_hdca_c      | 49.67  | 23.02  |
| sM_gly_c       | 55.44  | 79.3   |
| sM_stcoa_c     | 62.67  | 33.25  |
| sM_malACP_m    | 69.44  | 32     |
| sM_udp_c       | 71.44  | 87.28  |
| sM_cer1_24_c   | 85.44  | 30.09  |
| sM_adp_n       | 90.78  | 83.7   |
| sM_ACP_c       | 92.44  | 48.99  |
| sM_f6p_c       | 102.33 | 151.38 |
| sM_ttdca_e     | 111    | 59.08  |
| sM_ump_c       | 111.33 | 143.44 |
| sM_hdcea_c     | 114.89 | 118.09 |
| rR_GAT2_SC     | 128.11 | 71.55  |
| sM_atp_n       | 137.67 | 127.7  |
| rR_AGAT_SC     | 165.11 | 120.06 |
| sM_ocdycacoa_c | 183    | 110.02 |
| rR_RNDR3n      | 254.78 | 123.96 |
| sM_ddcacoa_c   | 267.89 | 140.76 |
| sM_3mob_c      | 278.44 | 148.2  |

EIGENVECTOR CENTRALITY: Stability threshold: 31.347

| Metabolite  | Average Rank | Std Deviation |
|-------------|--------------|---------------|
| sM_pmtcoa_c | 25.11        | 31.28         |
| rR_LPCAT_SC | 30.22        | 30.48         |

SUBGRAPH CENTRALITY: Stability threshold: 240.892

| Metabolite     | Average Rank | Std Deviation |
|----------------|--------------|---------------|
| sM_coa_x       | 11           | 19.12         |
| sM_accoa_x     | 18.44        | 16.87         |
| sM_pmtcoa_c    | 20.22        | 30.12         |
| sM_stcoa_c     | 22.67        | 30.83         |
| sM_glu__L_c    | 27.78        | 70.16         |
| sM_hdcoa_c     | 30.33        | 33.6          |
| rR_AGAT_SC     | 32.11        | 36.36         |
| sM_akg_c       | 34.78        | 61            |
| sM_ocdycacoa_c | 36.11        | 26.49         |

|              |        |        |
|--------------|--------|--------|
| sM_nh4_c     | 37.56  | 95.27  |
| sM_odecoa_c  | 37.78  | 41.95  |
| sM_ddcacoa_c | 38.44  | 28     |
| sM_dcacoa_c  | 46.67  | 26.6   |
| sM_atp_x     | 52.89  | 84.02  |
| sM_malcoa_c  | 61     | 27.46  |
| sM_gln_L_c   | 63.11  | 97.68  |
| sM_accoa_c   | 68.56  | 30.84  |
| sM_pyr_c     | 70     | 38.63  |
| sM_gly_c     | 72.22  | 35.89  |
| sM_ahcys_c   | 74.33  | 51.4   |
| sM_gdp_c     | 77.89  | 94.53  |
| rR_ACSp      | 84     | 79.39  |
| sM_ac_c      | 99.89  | 65.28  |
| sM_amet_c    | 110.11 | 58.03  |
| sM_gtp_c     | 129.78 | 88.12  |
| sM_o2_m      | 152    | 79.75  |
| sM_h2o2_c    | 174.89 | 121.31 |
| sM_udp_c     | 175.44 | 153.44 |
| sM_cys_L_c   | 179.67 | 233.07 |
| sM_adp_x     | 183.22 | 105.72 |
| sM_ACP_c     | 254.56 | 103.83 |
| sM_cer1_24_c | 296    | 139.18 |
| sM_cer2_24_c | 301.67 | 162.69 |
| sM_utp_c     | 351.56 | 222.16 |

## STABLE NODES ANALYSIS for RWER

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DEGREE CENTRALITY: Stability threshold: 327.933

| Metabolite    | Average Rank | Std Deviation |
|---------------|--------------|---------------|
| sM_cer1_26_c  | 104.89       | 146.31        |
| sM_q6h2_m     | 182.5        | 275.79        |
| sM_focyt_c    | 184.71       | 107.75        |
| rR_CYSTLp     | 204          | 128.34        |
| sM_psphings_c | 333.44       | 226.15        |
| rR_3DH5HPBMTm | 399.5        | 286           |
| sM_pap_c      | 404.25       | 306.74        |
| sM_thymd_c    | 410.33       | 248.49        |
| sM_cit_x      | 445.67       | 301.56        |

BETWEENNESS CENTRALITY: Stability threshold: 506.513

| Metabolite | Average Rank | Std Deviation |
|------------|--------------|---------------|
| sM_octa_c  | 649.83       | 417.83        |

CLOSENESS CENTRALITY: Stability threshold: 461.735

| Metabolite      | Average Rank | Std Deviation |
|-----------------|--------------|---------------|
| sM_cer1_26_c    | 374.78       | 386.15        |
| sM_focyt_c      | 386.29       | 388.21        |
| sM_cit_x        | 433.11       | 444.14        |
| rR_FAS100       | 436.88       | 408.69        |
| sM_q6h2_m       | 467.38       | 316.07        |
| sM_mipc326_SC_c | 517.5        | 387.75        |
| sM_dadp_c       | 648.25       | 452.65        |
| rR_CYSTLp       | 689.75       | 366.29        |
| sM_4h2oglt_m    | 796.29       | 455.33        |

PAGERANK CENTRALITY: Stability threshold: 557.167

| Metabolite   | Average Rank | Std Deviation |
|--------------|--------------|---------------|
| sM_hcys_L_c  | 67           | 51.27         |
| sM_cer1_26_c | 102.11       | 113.52        |
| sM_2obut_c   | 182.78       | 149.55        |
| sM_accoa_m   | 231.44       | 410.81        |
| sM_thymd_c   | 253.33       | 150.8         |
| sM_glyc_c    | 278          | 349.93        |

|               |         |        |
|---------------|---------|--------|
| sM_2mbald_c   | 300.11  | 198.73 |
| rR_CYSTLp     | 324.44  | 506.15 |
| sM_pspnings_c | 357.89  | 241.55 |
| sM_ibutoh_c   | 378.33  | 520.33 |
| sM_10fthf_c   | 396.89  | 491.07 |
| rR_ALATRS     | 428.22  | 402.71 |
| sM_iamac_c    | 432.89  | 319.36 |
| sM_4abz_c     | 462     | 414.69 |
| sM_ddcacoa_x  | 475.89  | 446.49 |
| rR_23CAPPD    | 522.78  | 422.49 |
| sM_ibutac_c   | 581.44  | 543.28 |
| rR_LEUTRS     | 587.22  | 453.98 |
| sM_akg_e      | 638.67  | 443.73 |
| rR_GGTT       | 660     | 354.9  |
| sM_pac_c      | 682.78  | 478.95 |
| sM_2phetoh_m  | 715.44  | 392.49 |
| sM_13BDgln_e  | 726.33  | 522.21 |
| rR_ADK4       | 811.89  | 446.82 |
| sM_achms_c    | 824     | 492.17 |
| sM_xtsn_e     | 852.78  | 532.2  |
| rR_2MBTOHt    | 854.56  | 456.53 |
| rR_MFAPS_SC   | 864.78  | 353.55 |
| sM_idp_c      | 868     | 551.81 |
| sM_tdcoa_x    | 912.89  | 521.08 |
| rR_HEXDPtm    | 1050.33 | 543.69 |
| rR_ALCD2irm   | 1082.78 | 541.37 |
| sM_dd2coa_x   | 1140.89 | 526.74 |
| sM_23camp_c   | 1307    | 547.78 |

EIGENVECTOR CENTRALITY: Stability threshold: 430.413

| Metabolite | Average Rank | Std Deviation |
|------------|--------------|---------------|
| ----       | ----         | ----          |

SUBGRAPH CENTRALITY: Stability threshold: 621.897

| Metabolite   | Average Rank | Std Deviation |
|--------------|--------------|---------------|
| sM_cer1_26_c | 171.78       | 227.25        |
| sM_dca_c     | 197.67       | 137.21        |
| sM_glx_c     | 334.33       | 182.42        |
| sM_coa_r     | 352.22       | 467.53        |
| sM_thymd_c   | 428.67       | 287.88        |

|                 |         |        |
|-----------------|---------|--------|
| rR_CYSTLp       | 484.44  | 447.67 |
| sM_psphings_c   | 540.11  | 355.71 |
| sM_L2aadp_c     | 589.67  | 374.85 |
| rR_AKGDbm       | 600.56  | 387.05 |
| sM_cit_x        | 611.22  | 387.4  |
| sM_fru_c        | 623.56  | 293.21 |
| sM_dadp_c       | 643.33  | 620.94 |
| rR_C24STRer     | 674.11  | 567.1  |
| rR_CITtcp       | 687.11  | 462.64 |
| rR_L_LACD2cm    | 687.89  | 609.99 |
| rR_DOLPMMer     | 697.33  | 619.27 |
| rR_TMDPP        | 701.78  | 436.21 |
| rR_3DH5HPBMTm   | 719.78  | 512.93 |
| sM_mipc326_SC_c | 725     | 541.62 |
| rR_CERS226      | 735.11  | 558.22 |
| sM_myrsACP_m    | 756.33  | 585.1  |
| sM_g6p_B_c      | 761.89  | 536.63 |
| sM_nadph_r      | 837     | 573.13 |
| sM_cyst_L_x     | 960.44  | 475.98 |
| sM_hcys_L_x     | 1021.11 | 480.66 |
| sM_cer1_24_r    | 1036    | 615.34 |
| rR_SBTd_D2      | 1147.67 | 600.25 |
| rR_GGTT         | 1232.22 | 548.33 |
| rR_IAMAct       | 1258.11 | 608.37 |
| sM_4abutn_c     | 1276.78 | 578.74 |
| sM_cdpchol_c    | 1354.56 | 554.21 |
| sM_s17bp_c      | 1369.22 | 561.09 |
| sM_pendp_c      | 1408.22 | 567.08 |
| sM_man_e        | 1468.33 | 585.16 |