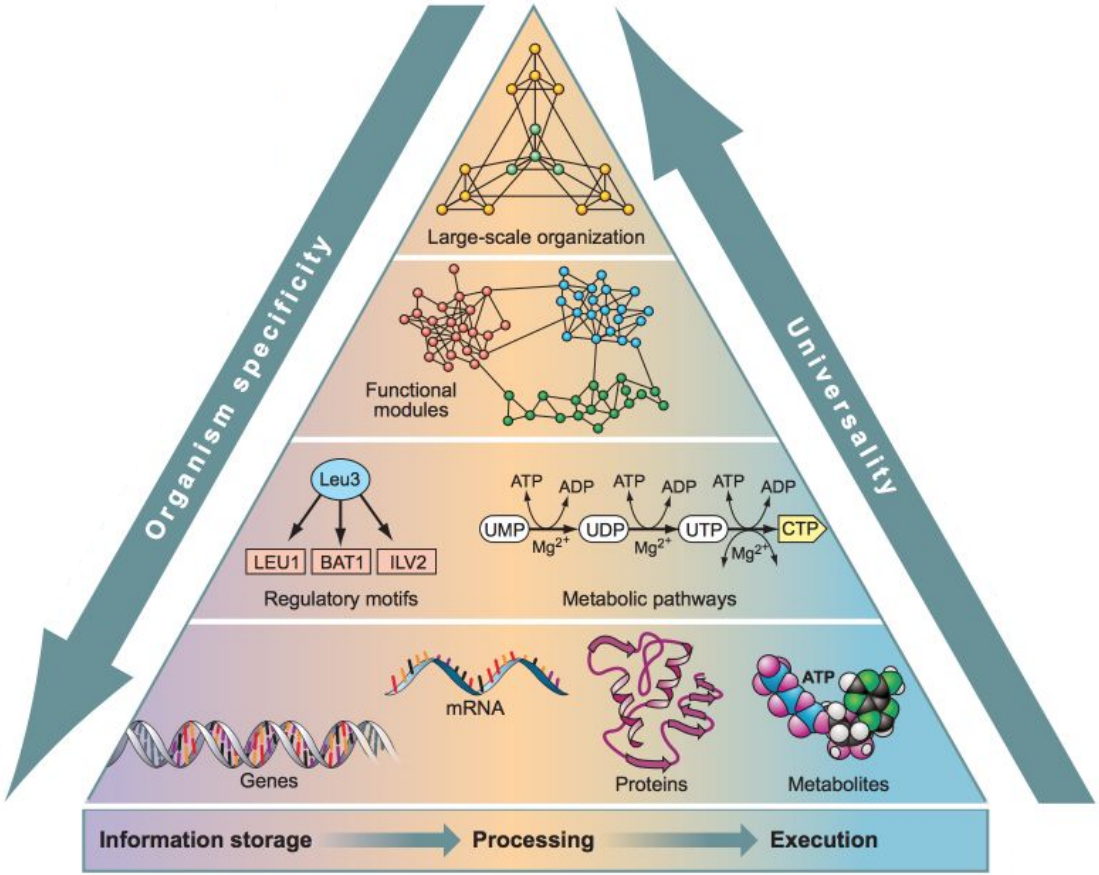
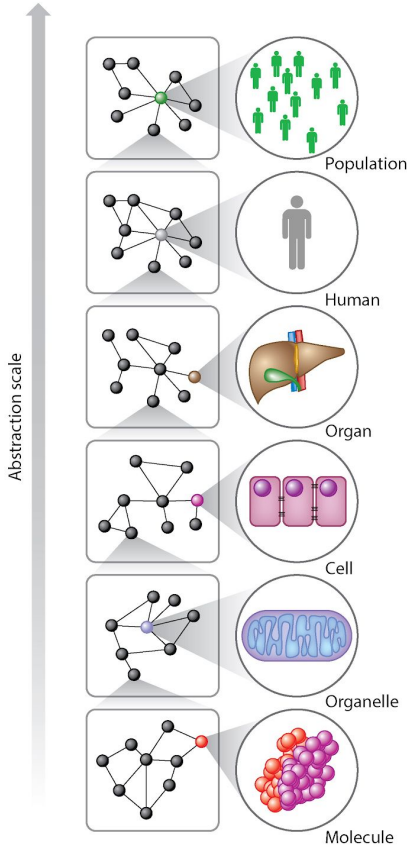
Week 15: Large-scale biological networks

- Network topology
- Network motifs
- Condition-specific networks
- Network reconstruction
- Network propagation

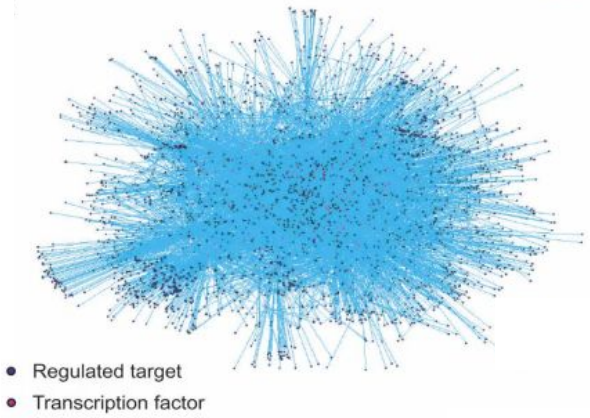
Layers of complexity and Network representations

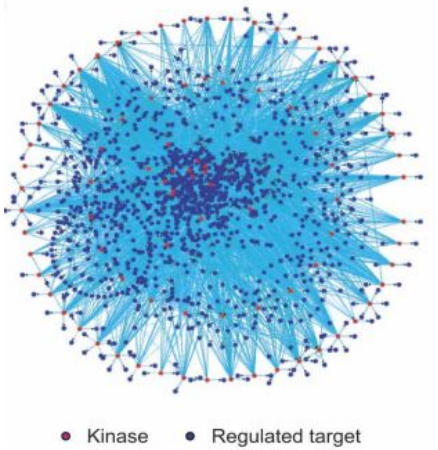


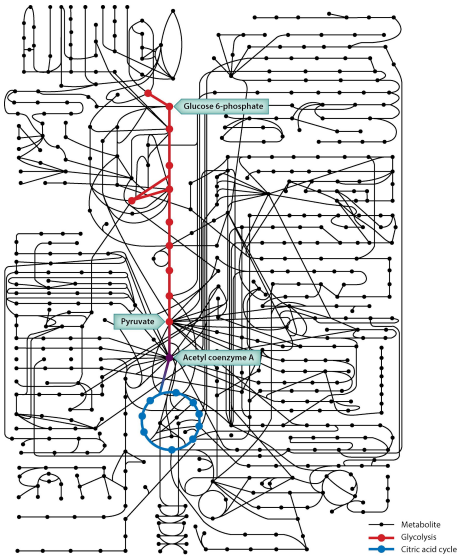


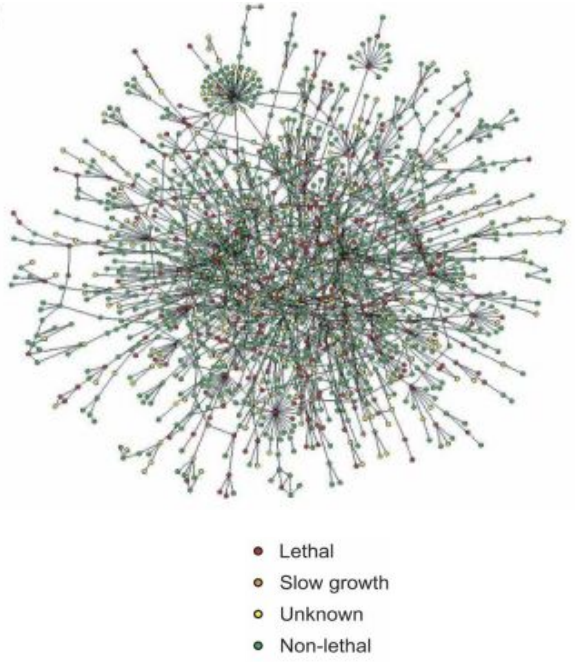
Oltvai, Barabasi (2002) Science; McGillivray (2018) Annu. Rev. Biomed. Data Sci.

Molecular networks



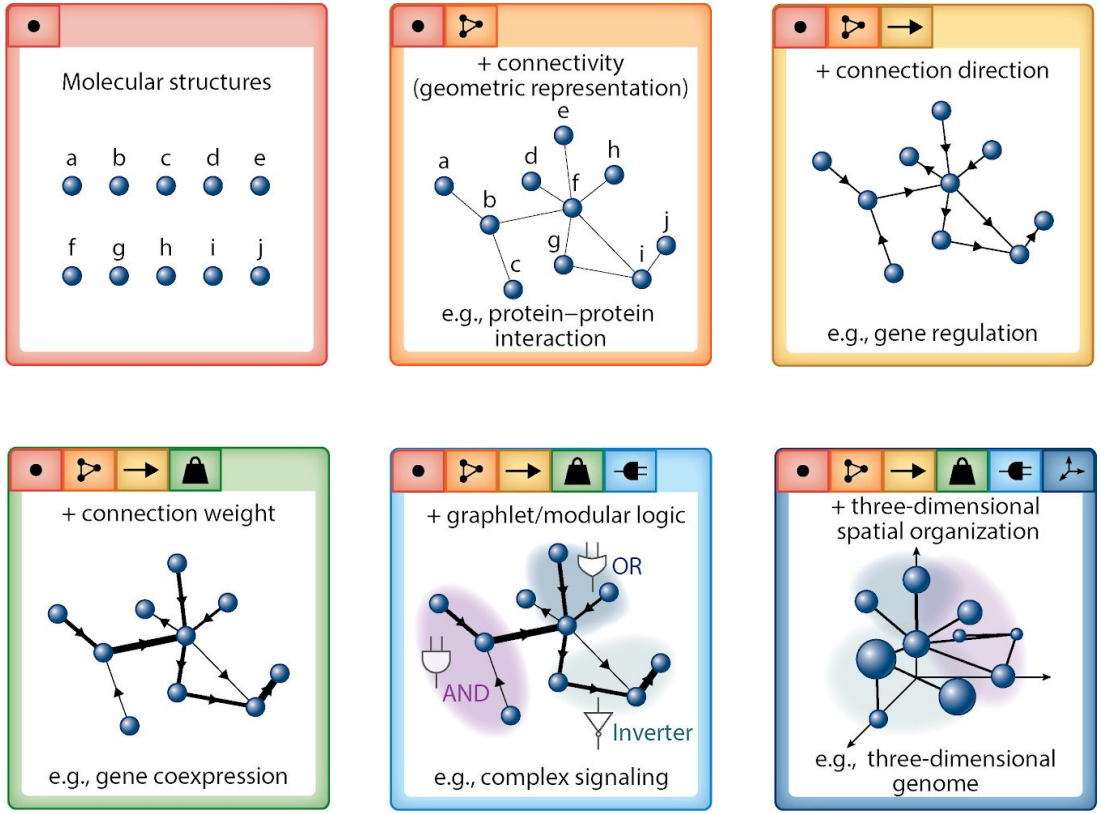






Zhu (2007) Genes & Dev.; McGillivray (2018) Annu. Rev. Biomed. Data Sci.

Network description

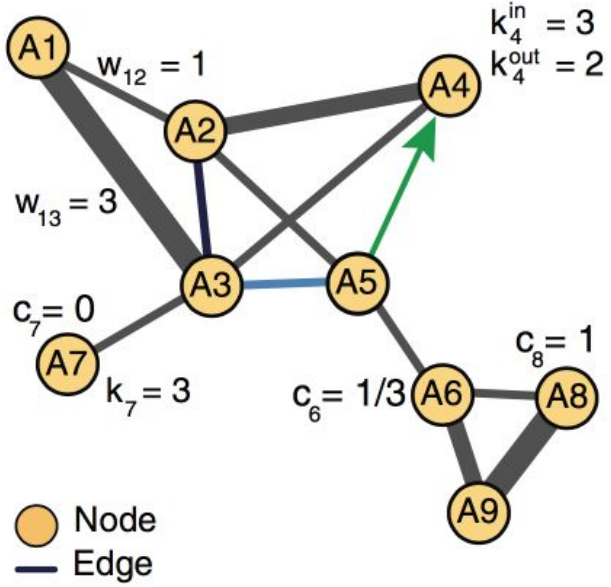


McGillivray (2018) Annu. Rev. Biomed. Data Sci.

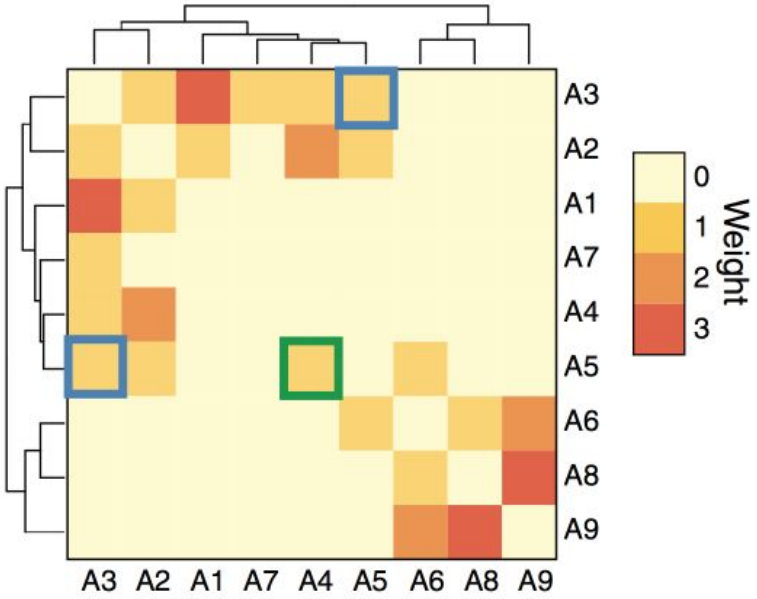
Network representations

Relationships	Optional weight
A1 ↔ A2	1
A1 ↔ A3	3
A2 ↔ A3	1
A2 ↔ A4	2
A2 ↔ A5	1
A3 ↔ A4	1
A3 ↔ A5	1
A3 ↔ A7	1
A5 → A4	1
A5 ↔ A6	1
A6 ↔ A8	1
A6 ↔ A9	2
A8 ↔ A9	3

Network

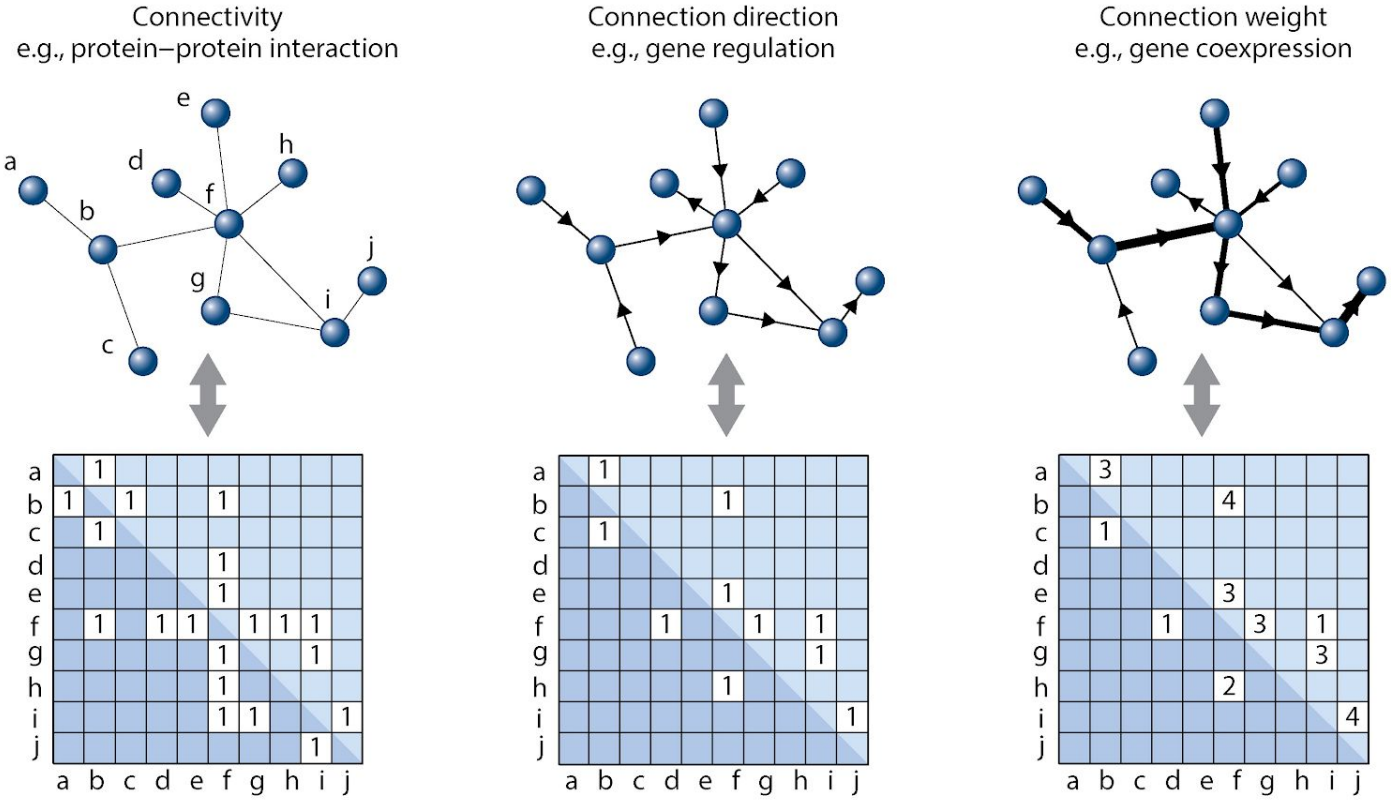


Heat map



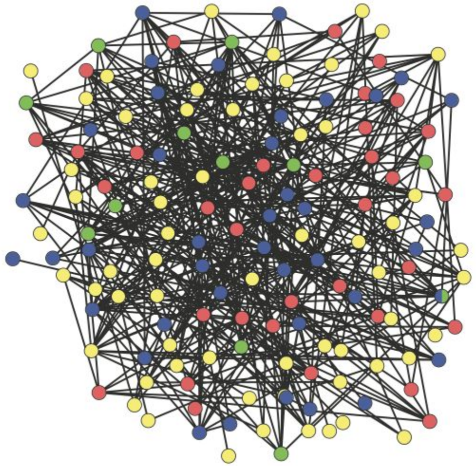
Merico (2009) Nat. Biotech.

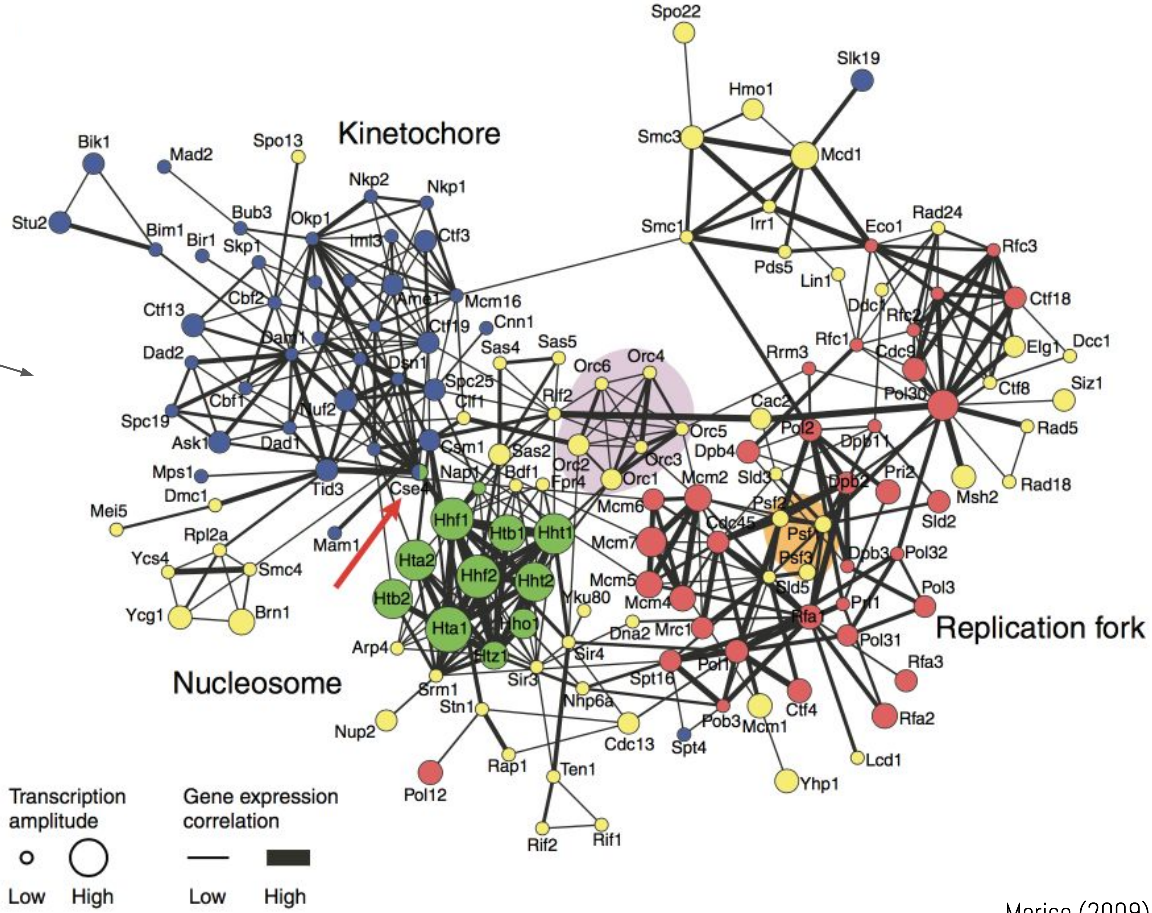
Network representations



McGillivray (2018) Annu. Rev. Biomed. Data Sci.

Network layout





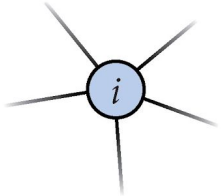
Merico (2009) Nat. Biotech.

Network topology

Degree

d_i

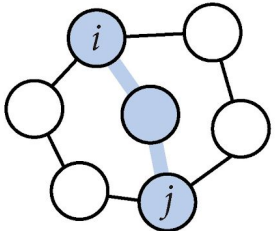
Number of nodes bound to node i



Shortest path distance

$d_{ij} = \min\{|e_p| \subset E_{ij}\}$

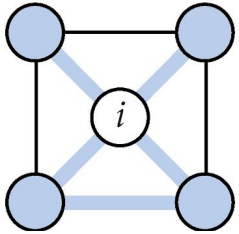
E_{ij}: all edge sets connecting nodes i and j



Clustering coefficient

$c_i / \binom{n_i}{2}$

c_i: edges connecting all n_i nodes bound to i

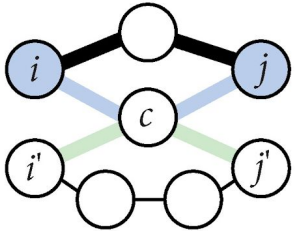


Betweenness centrality

$b_c = \sum_i \sum_j I_{ij} / s_{ij}$

s_{ij}: total number of shortest paths between i and j

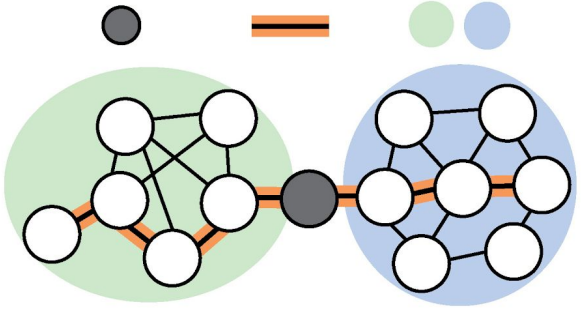
I_{ij}: 1 if c is within path; 0 otherwise



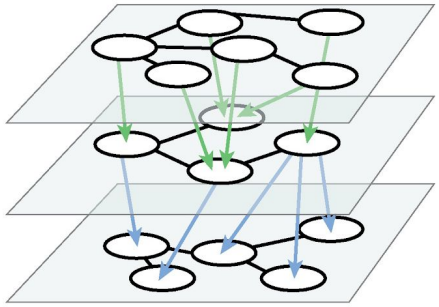
Bottleneck

Diameter

Modules

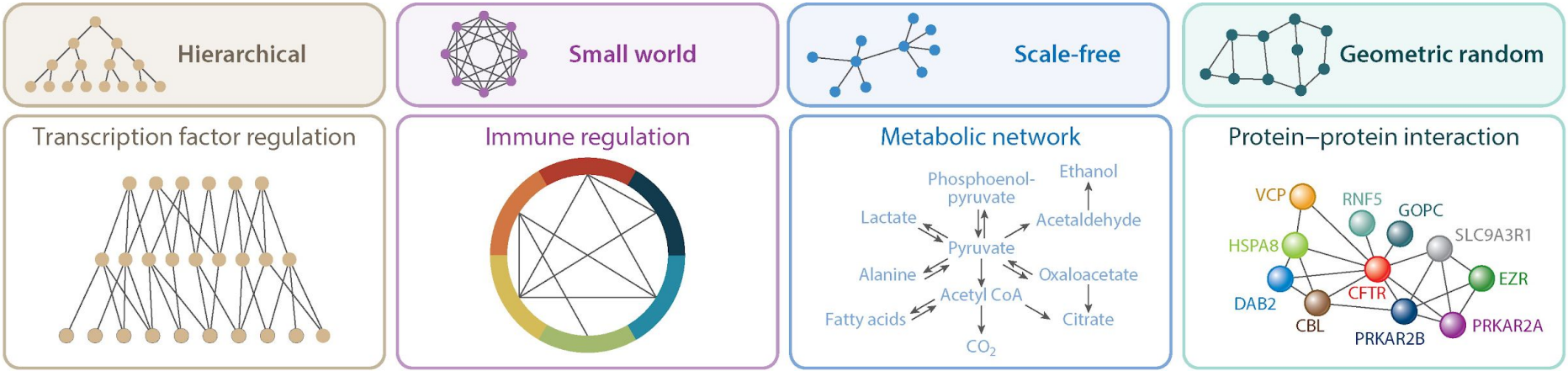


Network hierarchy



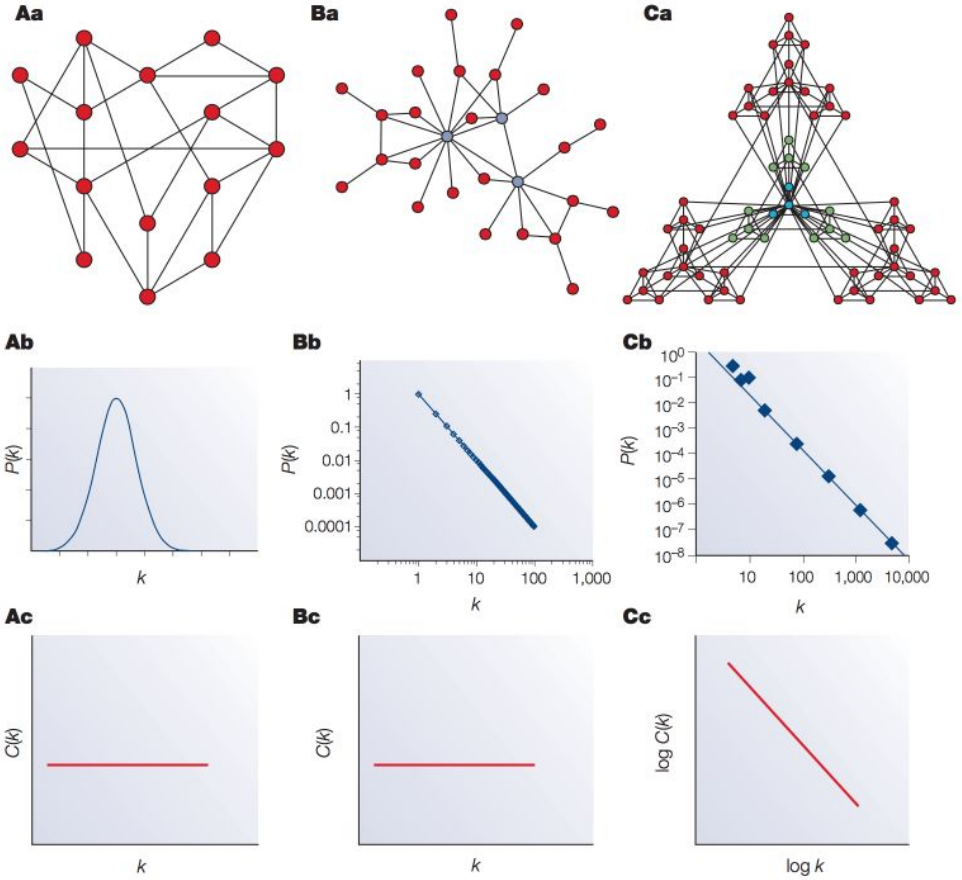
McGillivray (2018) Annu. Rev. Biomed. Data Sci.

Large-scale network topology



McGillivray (2018) Annu. Rev. Biomed. Data Sci.

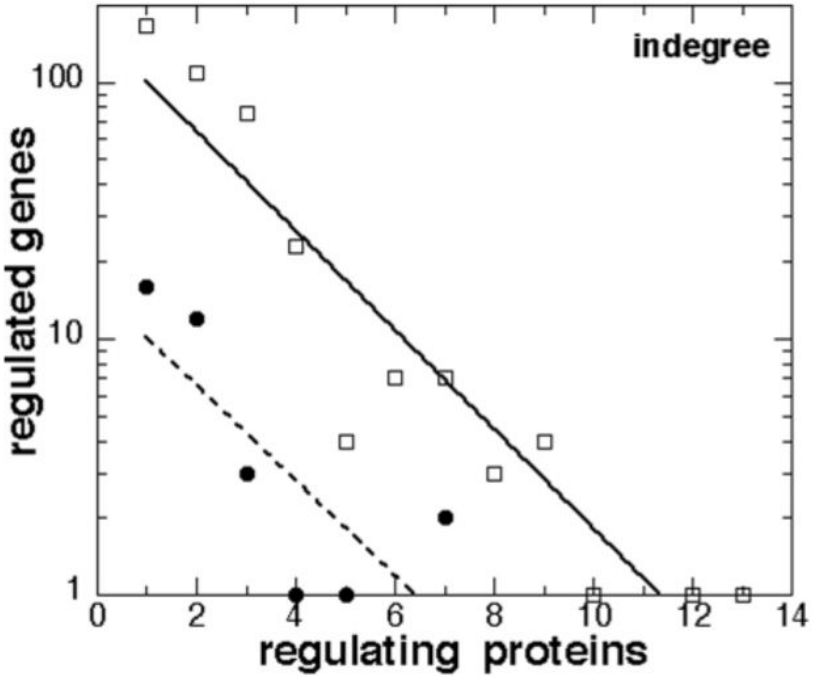
Network topology

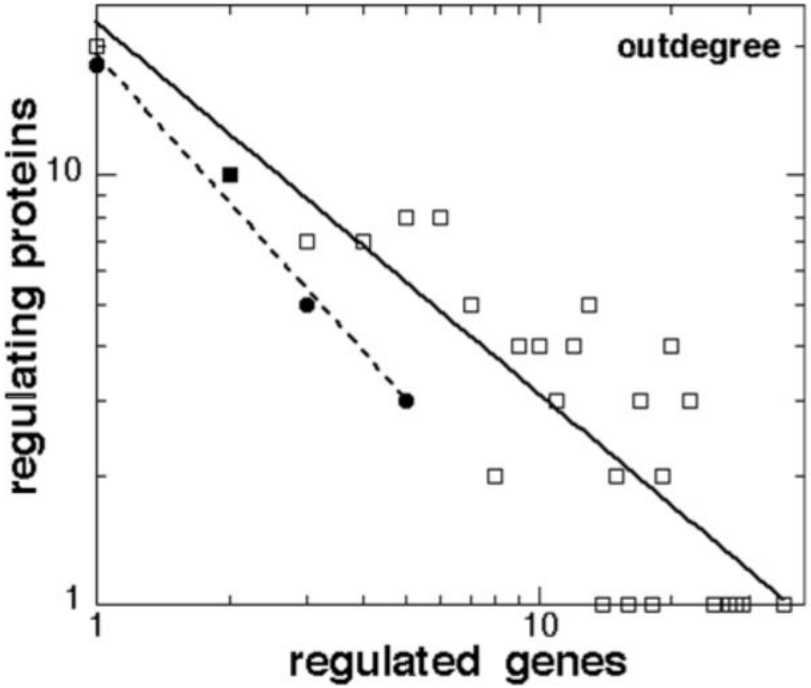


Barabasi, Oltvai (2004) Nat. Rev. Genet.

Network topology

Yeast TF-target network





Oltvai, Barabasi (2002) Science