From Proteomics to Systems Biology



Integration of "omics"- information

Outline and learning objectives

"Omics" science provides global analysis tools to study entire systems

- How to obtain omics data
- What can we learn? Limitations?
- Integration of omics data
- In-class practice: Omics-data visualization



Omics - data provide systems-level information



Omics - data provide systems-level information

Transcriptomics (indirectly) tells about RNA-transcript abundances



\Rightarrow primary genomic readout

Strengths:

very good genome-wide coverage
variety of commercial products

Drawback:

- No protein-level info!!
- -> RNA degradation
- -> Post-translational modifications
- => validation by e.g. RT-PCR



Proteomics aims to detect and quantify a system's entire protein content



Strengths:

- -> info about post-translational modifications
- -> high throughput possible due to increasing quality and cycle speed of mass spec instrumentation

Limitations:

- coverage dependent on sample, preparation & separation method
- bias towards most highly abundant proteins

Omics - data provide systems-level information



Metabolomics and Lipidomics



Metabolomics and Lipidomics



Metabolomics and Lipidomics



Glycomics identifies cellular glycan components and glycan-interacting factors



Omics - data provide systems-level information



<u>Limitations</u>: Methods still under development

http://www.functionalglycomics.org

'Localizomics' tells about sub-cellular locations

	secretory N
Bioinformatics	
TargetP http://www.cbs.dtu.dk/services /TargetP/	matrix N
	mitochondrial N + + + R T -8aa T matrix N
PSORT http://www.psort.org/	mitochondrial N + + + + R
Expasy -> Topology Prediction http://www.expasy.ch/tools /#proteome	chloroplast NA + hydroxylated + VRA AAV stroma N
	thylakoid MA + hydroxylated + VRA AAV AxAy lumen N
	(PTS1) SKL C
	peroxisome RLxxxxHL ((PTS2) N
Eukaryotic protein sorting signals	
	SP / IMS targeting / ITP hydrophobic region
	mTP (amphipathic α-helix) cTP
	MIP processed peroxisomal targeting signal
	Emanuelsson 2002

'Localizomics' tells about sub-cellular locations



Omics - data provide systems-level information









Omics - data provide systems-level information



Fluxomics looks at global and dynamic changes of metabolite levels over time





Omics - data provide systems-level information



Phenomics

High-throughput approaches to determine cellular fitness or viability in response to genetic / environmental manipulation

Some commonly used experimental approaches:



http://www.biolog.com/pmTechDesOver.html

Phenomics

=> RNAi screens



Integration of omics-data



http://systemsbiology.ucsd.edu



Integration of omics-data:



The holy grail of systems biology: Automatically updated, genome-scale, comprehensive network reconstructions for any system of interest => Advanced projects for some model organisms (Human, mouse, yeast, E. coli) Increasing Metabolic medical Toxicoengineering impact genomics Personalized drug Metabolic Metadesign Nutridisorders Cancer Omics genomics biology