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Lecture 1 - Part B -1

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Surveying Systems - Experimentally

Omics - an approach most often experimental that measures the many individual entities that make a system - currently an overused and sometimes abused term

Genomics - study of all (or most/many) genes involved in a certain physiological function -- even in the functioning of an entire organism

Uses sequencing and chips

Proteomics - study of many proteins at a time -- often less clearly identified with a specific function

Most often uses mass-spectrometry

Metabolomics - study of many metabolites in an organism, tissue, or cells

Most often uses liquid chromatography, mass-spectrometry

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Organizing the information from system–wide surveys:

Bioinformatics

Databases of human genes, mouse genes, gene expression patterns

Freely available on PubMed

Searchable

Often can be downloaded, and used for computational analysis

Big Data – a new buzz word is often used to describe these large data sets
Big data can be terabytes or petabytes of data or data sets that have many thousands to millions of records

Some commonly used Databases

mRNA profiling	**GEO**
microRNA	**Target Scan**
Proteins	**Swiss-Prot**
Genome-wide association studies	**DbGAP**
Disease Genes	**OMIM**
Drugs	**Pharm GKB**

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Computing from Databases

1. Statistical Co-relations between entities in a database
   e.g., mRNAs that are co-expressed under a specified condition

2. Statistical Co-relations between entities in different databases
   e.g., Mutated Genes in OMIM and mRNA expression patterns in disease states

From these types of statistical analysis we can generate lists (of genes, proteins, microRNAs, etc.) that can be related to a specific physiological or pathophysiological state.

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Network Models

From lists, we can build networks

Networks are systems consisting of entities (such as genes or proteins) and relationships (such as direct interactions) between these entities

The entities are called *nodes* and the relationships are called *edges*

Networks are computable systems and the computation can provide knowledge of how the system is organized

The branch of mathematics that deals with computation of network is called **graph theory**

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Bottom-up Modeling

Another approach for understanding how systems are put together is to identify one component at a time and the binary relationships between these components.

Many signaling pathways have been identified by this approach

Dynamical Models based on differential equations can quantitatively estimate how such pathways respond to certain stimuli

i.e., for a certain level of signal (concentration of hormone) what fraction of receptors are activated as a function, and how much intracellular signal does this receptor occupancy produce?

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Summary

1. Systems Biology builds on physiology, molecular biology, biochemistry and cell biology to understand how molecular components interact with one another to form functional units

2. Experiments in Systems Biology often involve measuring many cellular entities (e.g. genes, proteins lipids) simultaneously

3. Systems Biology integrates experiments and computational modeling to understand how systems function

The use of computation is a key feature of systems biology as compared to classic biological disciplines such as molecular biology, biochemistry and cell biology.

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Summary

Systems Biology has many branches, including

Genomics, Proteomics……

Bioinformatics, Network Modeling, Dynamical Modeling

Each of these is an active area of study by itself

Systems Biology is a broad multifaceted discipline**!**