### INTRODUCTION TO "OMICS"

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## Outline

- Definitions
- Omics
- Computer Language
- Genetics and Genomics
- Methods for Genomic Testing
  - Microarray
  - RNA Sequencing
- Articles
- Omics Nursing Education
- NINR Omics, Precision Health etc.





## What is Omics?

- "Omics": branches of science known informally as omics are various disciplines in biology whose names end in the suffix -omics, such as genomics, proteomics, metabolomics etc.
  - "Ome": used to address the objects of study of such fields, such as the genome, proteome or metabolome
- History: Bioinformaticians and molecular biologists were the first scientists to apply the "-ome" suffix widely (Cambridge, UK)

#### New Era of Health Care – "Omics"

#### • "Ome"

 Used to address the <u>objects</u> of study of such fields like the genome, proteome or metabolome

#### • "Omics"

- Informally refers to a field of study in **biology** ending in -omics
- Purpose of omics aims at the collective characterization and quantification of pools of **biological molecules** that translate into the structure, function, and dynamics of an organism(s)



### Types of Genomics

#### Genomics

- Cognitive genomics: Study of the changes in cognitive processes associated with genetic profiles.
- Comparative genomics: Study of the relationship of genome structure and function across different biological species or strains.
- Functional genomics: Describes gene and protein functions and interactions (often uses transcriptomics).
- Metagenomics: Study of metagenomes, i.e. genetic material recovered directly from environmental samples.
- Neurogenomics: Study of genetic influences on the development and function of the nervous system.
- Pangenomics: Study of the entire collection of genes or genomes found within a given species.
- Personal genomics: Branch of genomics that deals with the sequencing and analysis of the genome of individuals.



## Various "Omics"

- Proteomics
- Epigenomics
- Lipidomics
- Transcriptomics
- Metabolomics
- Nutrigenomics
- Glycomics
- Pharmacogenomics
- Toxicogenomics
- Psychogenomics
- Connectomics
- Foodomics



#### CLOSING IN ON THE SPIKES

• China - The results of genome sequencing, released on 10 January 2020, showed that the pneumonia outbreak was related to a new coronavirus, named 2019 novel coronavirus (2019-nCoV)





### Symptom Science and "Omics"







### **Computer Language**

- Computer storage is usually measured in byte multiples – e.g. an 820 megabyte (MB) hard drive holds 820 million bytes
- Kilobyte (KB)– 1024 bytes
- Megabyte (MG) 1024 KB
- Gigabyte (GB) 1024 MG
- Terabyte (TB) 1024 GB
- Petabyte (PB) 1024 TB
- Exabyte (EB) 1024 PB
- Zettabyte (ZB) 1024 EB

### Yottabyte (YB) – 1024 ZB



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What is the difference between genes and genetics

#### Genes

- Are the basic physical and functional unit of heredity
- Made up of DNA, act as instructions to make molecules particularly proteins
- Genetics
  - Study of heredity, or how the characteristics of living organisms are transmitted from one generation to the next via DNA, the substance that comprises genes, the basic unit of heredity.











**Genes** are molecules in our body that explain the information hidden in our DNA. **Genes** are also a small section of DNA, a chemical that has a genetic code for making proteins. Proteins are the building blocks for almost everything in our body, bones, blood and muscles, and it is the job of the genes to supervise protein production.

### Where are the Genes?

- Present in almost every cell's nucleus and are made from strands of DNA
- DNA is packaged in chromosomes within the nucleus, mitochondria also have a small amount of their own DNA.

#### \*\* Red **blood** cells, **have** no nucleus and no DNA.



DNA encodes all genetic information which is needed to build a cell.
 DNA consists of four building blocks:



These individual building blocks are also called "nucleotides". A feature of DNA is that these nucleotides are paired. Two pairs exist: A/T and G/C. The reason that these pairs go together are of chemical structure. This is the reason why DNA is structured as a double helix.

# What is in the Blood for you to obtain a genomic biomarker?



What is the difference between gene and genome **GENE** refers to a specific sequence of DNA on a SINGLE chromosome but **<u>GENOME</u>** encompasses the entire set of genetic information across ALL 23 chromosome pairs (includes all genes, genemodifying sequences and all the "other stuff in between")

What is the difference between genome and genomics

#### Genome

- the complete <u>set of genes</u> or genetic material present in a cell or organism
- the genome is the entire
  DNA content that is present
  within one cell of an
  organism

#### Genomics

 an area within genetics that concerns the <u>sequencing and</u> <u>analysis</u> of an organism's genome



### **Research in Genomics**

- Functional Genomics
  - Attempts to answer questions about the function of DNA at the levels of genes, RNA transcripts, and protein products. A key characteristic of functional genomics studies is their genome-wide approach rather than a more traditional <u>"gene-by-gene"</u> approach.
  - The high throughput analysis of all expressed genes is also called <u>Transcriptome Analysis</u>.
  - Transcriptome analysis can be conducted by 2 approaches:
    - 1) Microarray based approaches
    - 2) Sequence based approaches (RNA)

 Structural Genomics seeks to describe the 3dimensional structure of every protein encoded by a given genome



- Epigenomics study of the complete set of <u>epigenetic</u> modifications on the genetic material of a cell, known as the <u>epigenome</u>.
- The **epigenome** is a multitude of <u>chemical</u> compounds that can tell the genome what to do.



 Metagenomics - study of *metagenomes*, <u>genetic</u> material recovered directly from <u>environmental</u> samples.

#### THE NEW SCIENCE OF METAGENOMICS

**Revealing the Secrets of Our Microbial Planet** 





### What is Comparative Genomics?

It is the comparison of one genome to another.





### **DNA Microarray**

 Hybridization between two DNA strands, the property of <u>complementary</u> nucleic acid sequences to specifically pair with each other by forming <u>hydrogen bonds</u> between complementary <u>nucleotide base pairs</u>.















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#### **Center for Data Science**





### Pharmacogenomics and nutrigenomics

- Pharmacogenomics and nutritional genomics is a branch of science that examines personalized reactions to medications and nutrients.
- In the future, drug labels may contain information on genomic biomarkers and describe:
  - 1. Drug exposure and clinical response
  - 2. Risk for adverse events
  - 3. Genotype-specific dosing
  - 4. Mechanisms of drug action
  - 5. Polymorphic drug target and disposition genes



### The Role of the Microbiome

- The microbiome is defined as the collective genomes of the microbes (composed of bacteria, bacteriophage, fungi, protozoa and viruses) that live inside and on the human body. We have about 10 times as many microbial cells as human cells.
- The gut microbiome plays a very important role in your health by helping control digestion and benefiting your immune system and many other aspects of health. An imbalance of unhealthy and healthy microbes in the intestines may contribute various diseases.



### The Role of Metabolomics

- Metabolomics is a field of omics science that characterizes differing metabolites.
- Metabolomics involves evaluating the therapeutic outcomes of clinical drugs <u>by correlating</u> baseline metabolic profiles of patients with their responses.
- For example:
  - Aspirin-25% of patients who are high-risk for atherothrombotic events are aspirin-resistant.
- Metabolomics is being used to diagnose disease, understand disease mechanisms, identify drug targets, and customize drug treatments.

DeAnnue story. Metabolomics 4 minutes <u>https://www.youtube.com/watch?v=ox7B79C2</u> <u>Yhk&feature=emb\_rel\_end</u>

#### **Metabonomics and Microbiomics**

- The gut microbiota is implicated in the metabolism of many medical drugs with consequences for interpersonal variation in drug efficacy and toxicity.
- Gut microbes collectively encode 150-fold more genes than the human genome, including a rich repository of enzymes with the potential to metabolize drugs and hence influence their pharmacology.
- Example of drugs influenced by microbiome are:
  - Simvastatin
  - Metformin
  - Levodopa





Topic/Study Type	Content	Site
General	Talking glossary of genetic terms	www.genome.gov/glossary
Background	Online Mendelian Inheritance in Man (OMIM)	www.ncbi.nlm.nih.gov/omim
	Quanto - sample size calculator	http://hydra.usc.edu/gxe
	CaTS - power calculator	www.sph.umich.edu/csg/abecasis/cats/
	Genetic Power Calculator	http://pngu.mgh.harvard.edu/~purcell/gpc/
	Patient Reported Outcomes Measurement Information System (PROMIS)	www.nihpromis.org
	Consensus Measures for Phenotypes and Exposures (PhenX)	www.phenx.org
Gene Expression	Gene Expression Omnibus	www.ncbi.nlm.nih.gov/geo/
	Gene Ontology Database	www.geneonology.org/
	European Bioinformatics Institute	www.ebi.ac.uk/
	Serial analysis of gene expression (SAGE) database	www.sagenet.org
Genetic/Genomic Association	Catalog of published genome- wide association studies	www.genome.gov/gwastudies
	SNP database	www.ncbi.nlm.nih.gov/projects/SNP/
	International HapMap Project	http://hapmap.ncbi.nlm.nih.gov/
	Genes, Environment and Health Initiative	www.genome.gov/19518663
Epigenomics	Chromatin structure and function	www.chromatin.us
	Database for DNA Methylation and Environmental Epigenetic Effects	www.methdbe.de
	Database of noncoding RNAs	www.noncode.org
	Epigenomic datasets	www.ncbi.nlm.nih.gov/epigenomics
	Epigenomic Fact Sheet	www.genome.gov/27532724
	Histone Database	www.research.nhgri.nih.gov/histones
	Human Epigenome Project (HEP)	www.epigenome.org
	International Human Epigenome Consortium	http://ihec-epigenome.org
	MicroRNA data resource (miRBase)	www.mirbase.org
Proteomic Studies	Protein database	www.ncbi.nlm.nih.gov/protein
	Entrez Protein Clusters	www.ncbi.nlm.nih.gov/proteinclusters
	PRIDE: Proteomics	www.ebi.ac.uk/pride

**IDEntifications** Database

#### GENOMIC, TRANSCRIPTOMIC, EPIGENOMIC, AND PROTEOMIC APPROACHES BY YVETTE P. CONLEY



#### GWAS -Genome-Wide Association Study

- An approach to associate specific genetic variations with particular diseases.
- The method involves scanning the genomes from many different people and looking for genetic markers that can be used to predict the presence of a disease.



Improving -Omics-Based Research and Precision Health in Minority Populations: Recommendations for Nurse Scientists Jacquelyn Y. Taylor, PhD, and Veronica Barcelona de Mendoza, PhD

- <u>Purpose</u> of this article is to provide an overview of the role of nurse scientists in -omics-based research and to promote discussion around the conduct of -omics-based nursing research in minority communities
- Previous and Ongoing Omics Research
- National Institutes of Nursing Research–Supported -Omics Research
- Challenges and Considerations
- Conclusions and Recommendations



### NINR - Symptoms and Genomics

- Blueprint for Genomic Nursing Science
  - Recommendations to explore ways to further genomic nursing science to improve health outcomes
- PA-16-023 and PA-16-024 <u>Innovative</u> <u>Questions in Symptoms Science and</u> <u>Genomics</u>
  - Optimize innovation, insight and cutting edge conceptual and technological breakthroughs by catalyzing research that emanates from the identified innovative questions in symptom and genomic *nursing science*

### **Nursing Education**

- AACN essentials
  - Essentials of genetic and genomic nursing: Competencies, curricula guidelines and outcome indicators
  - Essential Genetic and Genomic for Nurses
    with Graduate Degrees
- 2016 Doctoral Education Conference Schedule
  - Enhancing Nursing Science and Improving
    Patient Care through Big Data
  - Integrating <u>Omics Content in PhD</u> Programs

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### Nursing

 NINR – Bootcamp -Precision Health: From 'Omics' to Data Science

- Precision Health
- Symptom Science



### Omics to Advance Symptom Science Research June 22, 2020 | 12:00–3:30 P.M. ET



### Linking Omics with Symptom Science

# ONSEN

NINR Omics Nursing Science & Education Network (ONSEN) - 2018

- The goal of ONSEN is to advance omics nursing research and education and to facilitate collaborations, mentoring, and access to training opportunities.
- ONSEN content was developed by a workgroup of experts in genomics and other omics (e.g. microbiomics, metabolomics, proteomics), education, practice, and nursing research.
- Nurse scientists and trainees will be able to leverage samples and datasets, locate mentors and collaborators, disseminate information on pre- and post-doctoral training opportunities, and build skills for integrating omics into their programs of research.



#### Nursing and Omics

- Teach to not FEAR science of omics and techniques
- View Unknown as FUN and Exciting
- Watch and Learn at any opportunity
- COLLABORATE share

# Thank you!

### Questions?