

Meet the ‘omics’

The very nature of scientific study seeks to answer questions and these answers almost always lead to new questions. Biology, the study of life, is no exception. There are new areas of biology that continue to build on previous answers, some of these are referred to as the ‘omics’. Let’s take a look.

Genomics

The sequencing of the human genome has become one of the big milestones in the ‘omics’ sciences. The Human Genome Project sought to develop a representative sequence map of human DNA, our genetic material. The *genome* can be defined as the complete set of genes inside the cell. *Genomics* is, therefore, the study of the genetic make-up of organisms.

genome - the term for the complete set of genes inside the cell

genomics - the study of the genetic make-up of organisms

Genomics usually involves sequencing all the bases in an organism’s DNA, each A, T, C, and G (adenine, thymine, cytosine, and guanine, respectively). For the human genome there are over 3 billion bases, and these make up from 30,000 to 35,000 genes.

Once a genome is sequenced it is used for studies of function of the numerous genes (functional genomics), or comparison of the genes in one organism with those of another (comparative genomics).

Genomics can be seen as an entry point for looking at the other ‘omics’ sciences. The information in the genes of an organism, its *genotype*, is largely responsible for the final physical makeup of the organism - scientifically referred to as the *phenotype*. The environment also has some influence on the phenotype - so organisms are often more than the sum of their parts.

The DNA in the genome is only one aspect of the complex mechanism that keeps an organism running - so decoding the DNA is one step towards understanding, but by itself it doesn’t specify everything that happens within the organism.

genotype - the internally coded, inheritable information carried by all living organisms

phenotype - the physical manifestation of the genes and the environment in an organism

Let’s look at the flow of information from the genome of an organism to its phenotype. Along the way we will run into a few more ‘omics’.

The basic flow of genetic information in a cell is as follows. The DNA is *transcribed*, or copied, into a form known as RNA. The complete set of RNA in a cell can be referred to as its *transcriptome*. The RNA is subject to some editing (cutting and pasting) to become messenger-RNA, which carries information to the ribosome. Ribosomes, the protein factories of the cell, *translate* the message into protein.

transcriptome - the term for the complete set of RNA messages coded from the DNA within a cell

So, *transcription* of DNA into RNA and the subsequent *translation* of RNA into protein are the basic mechanisms by which cells mediate their growth, function, and metabolism.

Proteomics

Proteins are responsible for an endless number of tasks within the cell. The complete set of proteins in a cell can be referred to as its *proteome*. The study of protein structure and function and what every protein in an organism is up to is *proteomics*. One studying proteomics therefore seeks to understand the state of all these different proteins at any given moment in any given cell.

proteome - the term for the complete set of proteins within a cell

proteomics - the study of the way proteins work inside cells, and how they interact with each other

The goal is to understand how the structure and function of proteins (and their post-ribosomal modifications) allow them to do what they do, who or what they interact with, and how they contribute to life processes.

Glycomics

Glycomics seeks to study the sugars in an organism and the roles they play. Some believe that sugars play as vital a role in making the cell function as do the proteins. Sugars combine to form giant molecules such as carbohydrates and cellulose; they are known to regulate hormones, organize embryonic development, direct the movement of cells and proteins throughout the body, and to regulate the immune system.

glycome - the set of sugars an organism or cell makes.

glycomics - refers to the study of sugars within organisms, their structure, function, and, interaction; it encompasses identification, analysis, and management of glycol-information

Metabolomics

The next of the 'omics' to consider is *metabolomics*. Metabolomics is one of the newest 'omics' sciences. The metabolome refers to the complete set of low molecular weight compounds in a sample. Metabolomics aims at determining a sample's profile of these compounds. These compounds are the substrates and by-products of enzymatic reactions and have a direct effect on the phenotype of a cell.

Genomics and proteomics have provided extensive information regarding genotype but convey limited information about phenotype. Low molecular weight compounds are the closest link to phenotype, making metabolomics a logical technology from which to develop diagnostics (for example in studying a particular disease).

Metabolomic research is currently used to aid drug discovery and development. Metabolomics can also add value to ongoing genomic and proteomic research. The combination of these three sciences provides more meaningful data than would result from any one alone.

Understanding biological function and phenotype variation requires a mix of genomic, proteomic, and metabolomic information.

metabolome - the term for the complete set of low molecular weight compounds in a sample

metabolomics - the determination and study of the low molecular weight compounds in a sample

Metabolomics can be used to determine nutritional differences either between different genetically modified crops or between GM crops and traditional crops. The technology can also help to discover plant genes and to design effective herbicides and pesticides.

Understanding gene function requires a multidisciplinary approach, bringing together scientists from a wide array of fields to make sense of the vast amounts of data defining the genome, the transcriptome, the proteome, the glycome, the metabolome, and the phenotype.

What was that about answers spawning more questions?

For more information:

Genome Canada website:

<http://www.genomecanada.ca>

National Human Genome Research Institute:

<http://www.genome.gov/>

<http://www.genome.gov/Pages/Hyperion/educationkit/index.html>

Science at a Distance - Biological Information:

<http://www.brooklyn.cuny.edu/bc/ahp/BioInfo/SD.BI.HP.html>

National Center for Biotechnology Information:

http://www.ncbi.nlm.nih.gov/Entrez/Genome/main_genomes.html

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