5

GENOMICS AND PROTEOMICS

Genomics

Genomics is a discipline in genetics that applies recombinant DNA, DNA sequencing methods, and bioinformatics to sequence, assemble, and analyze the function and structure of genomes (the *complete* set of DNA within a single cell of an organism), determination of the entire DNA sequence of organisms and genetic mapping. The field also includes studies of intragenomic phenomena such as heterosis, epistasis, pleiotropy and other interactions between loci and alleles within the genome. Genomics was established by Fred Sanger when he first sequenced the complete genomes of a virus and a mitochondrion. His group established techniques of sequencing, genome mapping, data storage, and bioinformatics analyses in the 1970-1980s. The actual term 'genomics' is thought to have been coined by Dr. Tom Roderick, a geneticist at the Jackson Laboratory (Bar Harbor, ME). The sequencing of the genome of the model plant *Arabidopsis thaliana* (2000), which was carried out by an international consortium with the support of the European Commission, was a milestone in plant genomics research. Genomics has been playing a lot of contribution in the field of plant biotechnology for crop improvement. Annotated genome sequence data of various plants and microbes makes possible development of genetically modified crops of better quality than the existing crops. Some applications of genomics have been given hereunder:

1. *Bacillus thuringiensis* is a bacterium that synthesizes a protein (delta endotoxin) during sporulation and this protein is toxic to insect pests. Complete genome sequencing of *B. thuringiensis* has showed that this toxic protein (Bt toxin) is coded by *cry* gene present in the bacterium. A number of *cry* genes have been isolated so far from *B. thuringiensis* and by using *Agrobacterium* mediated gene transfer method, this gene has been transferred to cotton, tobacco, brinjal, sweet corn and tomato. These transformed crops show resistance against insect pests.

2. Genomics studies have allowed scientists to develop cereal varieties that have a greater tolerance for soil alkalinity, free aluminum and iron toxicities. These varieties of cereals can grow in poor soil areas.

3. Sequencing the rice genome provides a model for a small monocot genome. Rice was selected because its genome is 6, 10, and 40 times smaller than maize, barley, and wheat respectively. Sequenced rice genome has made easier to identify and isolate genes from grains with larger genomes. DNA sequence analysis of cereal grains is important for identifying genes associated with disease resistance, crop yield, nutritional quality, growth capacity and these information help to develop GM cereals with disease resistance, high yield, nutritional quality etc.

4. Genomics study and genetic engineering has allowed researchers to modify seed oil biochemistry to produce "designer oils" for edible and nonedible products. One technique modifies canola oil to replace cocoa butter as a source of saturated fatty acids. High-lauric acid canola has been planted in several countries and used in both foods and soaps.

5. Genomics studies makes possible development of golden rice 1 with high vitamin A content by transferring three foreign genes to rice – two genes namely Phytoene synthase gene (*psy*) and lycopene β-cyclase gene (*lcy*) from *Narcissus pseudonarcissus* and one gene namely carotene desaturase gene (*crtl*) from *Erwinia uredovora* and Golden Rice 2 by transferring *psy* gene from maize and *crtl* gene from *Erwinia uredovor.*

Proteomics

Proteomics is the large-scale study of proteins, particularly their structures and functions. Proteins are vital parts of living organisms, as they are the main components of the physiological metabolic pathways of cells. The term *proteomics* was first coined in 1997 to make an analogy with genomics, the study of the genome. The word *proteome* is a blend of ***prote**in* and *gen**ome***, and was coined by Marc Wilkins in 1994 while working on the concept as a Ph.D. student.

The proteome is the entire set of proteins, produced or modified by an organism or system. It is an important component of functional genomics. Proteomics can play specific roles to fulfil the growing demand for food. The advent of proteomics has allowed researchers to identify a broad spectrum of proteins in living systems. This could help to find the functional important proteins or their modifications that could not be found through the studies at any other levels. This capability is especially useful for agriculture because it may give clues not only about nutritional value but also about traits such as yield and how these factors are affected by adverse environmental conditions. Proteomics technology has unraveled a great number of proteins which play crucial roles in plant growth/development and adaptation to environmental stresses. Functional analyses of those proteins will contribute to develop stress-resistant/tolerant crops and artificially regulated crops. Some applications of proteomics in crop improvement have given below:

1. Proteomics helps in determination of plant proteins that are related to abiotic and biotic stresses. Interaction between crops and other organism is an important factor that influences the growth and yield of crops. For example, the pathogen *Fusarium graminearum* causes head blight of small grain cereals and reduces grain yield and quality. Proteomics helps to analyses the interaction between crop and the pathogen and helps to find out measure to control the pathogen attack.

2. Proteomics study helps to know the interaction between symbiotic bacteria and host in legume root nodules by studying the structure and function of proteins involve in the interaction and this

could help in developing artificial crops (other than leguminous plant) forming root nodules in association with symbiotic bacteria.

3. C4 plants are more efficient in photosynthesis than C3 plants as they contain two types of chloroplasts. Comparative proteomics helps to determine the key components that influence the efficiency of Sunlight conversion. This also provides information in development of artificial C4 plants.

4. Proteomics studies helps in understanding the mechanism of seed germination, e.g. in rice. Proteomics study on gene expression regulation, reserve food mobilization, metabolism reactivation has brought new insights on the mechanism of metabolism regulation during seed germination, which will certainly help in solving the problem arise during seed germination of various plants.

5. Proteomics studies help to determine the cause and process (earlier how and why) of male sterility and proteins which are responsible for microspore abortion. Thus in future it will help in developing artificial male sterile crops and will contribute a lot in hybridization programs.