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IMPORTANCE AND APPLICATIONS OF BIOINFORMATICS IN THE FIELD OF AGRICULTURE

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Introduction

Term Bioinformatics was invented by Paulien Hogeweg and Ben Hesper in 1970 as "the study of informatic processes in biotic systems". Paulien Hogeweg is a Dutch theoretical biologist and complex systems researcher studying biological systems as dynamic information processing systems at many interconnected levels.

Bioinformatics: (Molecular) Bio - informatics = is conceptualizing biology in terms of molecules (in the sense of physical-chemistry) and then applying "informatics" techniques (derived from disciplines such as applied math, CS, and statistics) to understand and organize the information associated with these molecules, on a large scale.

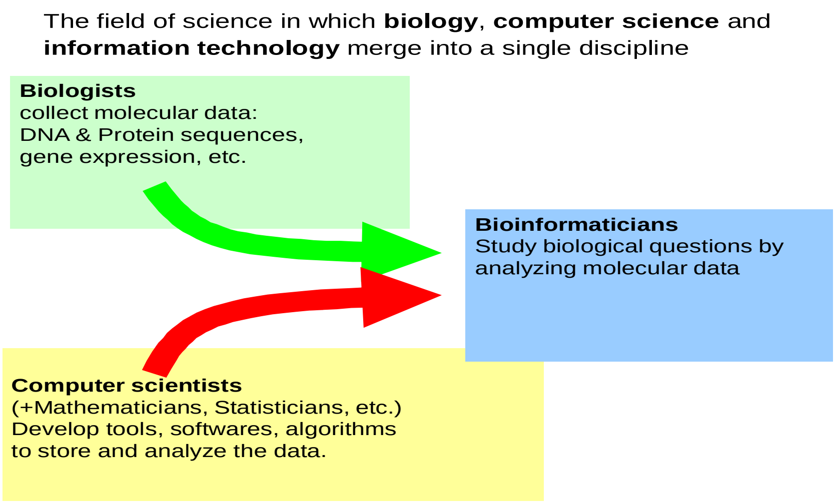
Bioinformatics is the field of science in which biology, computer science, and information technology merge into a single discipline. The ultimate goal of the field is to enable the discovery of new biological insights as well as to create a global perspective from which unifying principles in biology can be discerned.

There are three important sub-disciplines within bioinformatics:

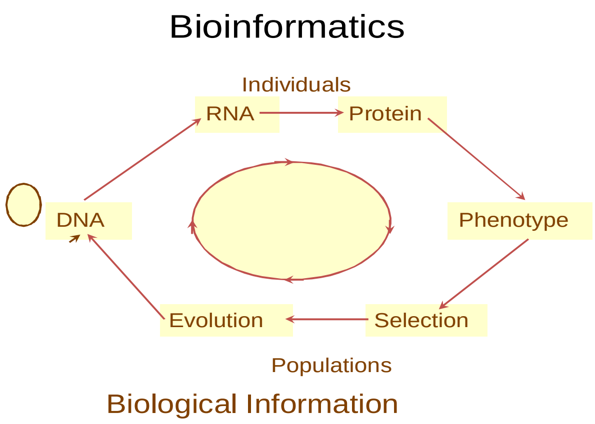
1. The development of new algorithms and statistics with which to assess relationships among members of large data sets
2. The analysis and interpretation of various types of data including nucleotide and amino acid sequences, protein domains and
3. Protein structures; the development and implementation of tools that enable efficient access and management of different types of information.

Why is bioinformatics important

The greatest challenge facing the molecular biology community today is to make sense of the wealth of data that has been produced by the genome sequencing projects. Traditionally, molecular biology research was carried out entirely at the experimental laboratory bench but the huge increase in the scale of data being produced in this genomic era has realized a need to incorporate computers into the research process. With he advent of new tools and databases in molecular biology we are now enable to carry out the research not only at genome level but also at proteome, transcriptome and metabalome levels. The challenges faced by the bioinformatics community today is the intelligent and efficient storage of huge amount of data generated, and to provide easy and reliable access to this data



. Therefore, incisive computer tools must be developed to allow the extraction of meaningful biological information. Emerging trend in pharma industry is to apply bioinformatics tools to reduce time and cost in molecular marker development, drug development.



Bioinformatics is being used in following fields:

- ✓ Microbial genome applications
- ✓ Molecular medicine
- ✓ Personalised medicine
- ✓ Preventative medicine
- ✓ Gene therapy Drug development Antibiotic resistance Evolutionary studies Waste cleanup Biotechnology
- ✓ Climate change Studies
- ✓ Alternative energy sources
- ✓ Crop improvement
- ✓ Forensic analysis
- ✓ Bio-weapon creation
- ✓ Insect resistance
- ✓ Improve nutritional quality
- ✓ Development of Drought resistant varieties
- ✓ Vetinary Science

In the field of Agriculture, applications of bioinformatics are in following areas:

a. **Crop Improvement:** Comparative genetics of the plant genomes has shown that the organisation of their genes has remained more conserved over evolutionary time than was previously believed. These findings suggest that information obtained from the model crop systems can be used to suggest improvements to other food crops. Arabidopsis thaliana (water cress) and *Oryza sativa* (rice) are examples of available complete plant genomes. Arabidopsis thaliana was the first plant to be sequenced and is considered the model species for investigating plant genetics and biology. There are many genes which are similar in all plants and the study of genes in a model organism like A. thaliana facillitates our understanding of gene expression and function in all plants. Furthermore, since animals and plants are both eukaryotes, many of the genes found in A. thaliana have homologs in animals. Arabidopsis has the smallest genome of any flowering plant, which is the main reason it was selected as a model organism for genome sequencing The DNA of Arabidopsis is made up of about 140 million bases, which are parcelled into five chromosomes. *Oryza sativa* (rice) is the most important crop for human consumption, providing staple food for more than half of the world population. *Oryza sativa* was the cereal selected to be sequenced as a priority and has gained the status "model organism". It has the smallest genome of all the cereals: 430 million nucleotides and it can serve as a model genome for one of the two main groups of flowering plants, the monocotyledons. Because it has been the subject of studies on yield, hybrid vigor, genetic resistance to disease and adaptive responses, scientists have taken advantage of the existence of a multitude of varieties that have adapted to a very wide range of environmental conditions, from dry soil in temperate regions to flooded cultures in tropical regions.

b. **Insect Resistance:** Genes from *Bacillus thuringiensis* that can control a number of serious pests have been successfully transferred to cotton, maize and potatoes. This new ability of the plants to resist insect attack means that the amount of insecticides being used can be reduced and hence the nutritional quality of the crops is increased . *Bacillus thuringiensis* is a pathogenic bacteria used for insect control. It is Gram-positive spore-forming, rod-shaped aerobic bacteria in the genus Bacillus. *B. thuringiensisis* an insecticidal bacterium, marketed worldwide for control of many important plant pests - mainly caterpillars of the Lepidoptera (butterflies and moths) but also mosquito larvae, and simuliid blackflies that vector river blindness in Africa. *B. thuringiensis* products represent about 1% of the total 'agrochemical' market (fungicides, herbicides and insecticides) across the world. The commercial *B. thuringiensis* products are powders containing a mixture of dried spores and toxin crystals. They are applied to leaves or other environments where the insect larvae feed. The toxin genes have also been genetically engineered into several crop plants.

c. **Improve Nutritional Quality**: Scientists have recently succeeded in transferring genes into rice to increase levels of Vitamin A, iron and other micronutrients. This work could have a profound impact in reducing occurrences of blindness and anaemia caused by deficiencies in Vitamin A and iron respectively. Scientists have inserted a gene from yeast into the tomato, and the result is a plant whose fruit stays longer on the vine and has an extended shelf life. One little gene may be all that stands between a fresh, juicy, homegrown tomato and its bland, store-bought counterpart. Biologists announced that they've identified the gene that controls the ripening process in the humble fruit. If this "rin" gene can be manipulated effectively, scientists will be able to create breeds of tomatoes that will be more flavorful even after the long journey from the vine to the produce department. Today, tomatoes are plucked from the vine early, when still green and firm, to ensure that they survive shipping without bruising and rotting. Picking tomatoes early means they have less chance to develop flavor, color, and nutrients naturally. By manipulating the "rin" gene, scientists will be able to slow the ripening process, letting the tomato develop on the vine for longer but still keeping it firm enough to ship safely. The scientists responsible for the "rin" gene findings are from the U.S.

Department of Agriculture and the Boyce Thompson Institute for Plant Research, on the campus of Cornell University. They hope that their technique may also be applied to other fruits such as strawberries, bananas, bell peppers, and melons which suffer from the same shipping and storage complications.

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