Genomics Catalyzing the Biological Research

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Sequencing the genome of an organism, or transcriptome of a cell line, or a tissue to know its composition, is the key to understand complex biological processes. The first-generation dideoxy Sanger DNA sequencing method has been used to sequence several genomes including viruses, bacteria, fungi, animals (including human), and plants. With the help of the whole genome information, scientists have identified many novel genes, genetic variations, functional elements, and expression pattern of genes in various tissues/cell types. However, this paradigm-changing technology until recently was confined to large-genome centers and was associated with high cost and labor. A relatively recent technological breakthrough, Next-Generation Sequencing (NGS) allows whole genomes to be sequenced at a much lower cost and in a short period allowing this technology to be within the reach of individual researchers/laboratory. The $1000 genome program (http://www.genome.gov/12513162) has transformed genomics by introducing several second-generation NGS technology platforms such as pyrosequencing by 454 and Ion Torrent and sequencing by synthesis by Illumina sequencing. More recently, third-generation sequencers have emerged into the NGS market such as Pacific Biosciences and Oxford Nanopore. The high-throughput parallel DNA sequencing has reduced the cost (from $100 millions to $1000), time (months to hours), and manpower (thousands to an individual or automated) for human genome sequencing. The DNA sequencing throughput has increased to 10 fold per year, which compete with the computing speed of Moore's Law.

Sequencing single genome is not enough, and hence thousands of population genome projects emerged to sequence;

100000 human genomes (https://www.genomicsengland.co.uk);

10,000 birds genomes (https://b10k.genomics.cn);

10,000 plant genomes (https://db.cngb.org/10kp);

5000 insect genomes (http://arthropodgenomes.org/wiki/i5K).

All these developments are transform our understanding of life on earth and their evolutionary relationship at the deeper molecular level.