The role of genomics in cancer medicine

ASSIGN BUSTER

Genomics is a new science which concerns the study of genomes, the entire complement of genetic material of an individual. In fact, genomics also includes the study of gene expression, from transcription of DNA to translation, its expression as a protein. Genomics aims at understanding the structure, function and evolution of all genomes. This field is based on determining the essential nature of genome structure and will have a great impact on the development of basic biology. A genome is the total number of all genes found in an organism. Again, genomics can hence be defined as the study of all the genes in a cell at the DNA, mRNA and protein levels.

The era of genomics started with Frederic Sanger who first sequenced the complete genomes of a virus and a mitochondrion. Techniques of genomics which include DNA sequencing and gene mapping were hence established. Development in the field of genomics continued at a rapid pace, and with the new technology from informatics, scientists were inspired to carry out the Human Genome Project. This scientific research had, as a primary aim, to determine the base pair sequence in human DNA and to identify about 25 000 genes in the genome. The project started in 1990 and a first draft was released in 2000. A further, complete report was published in 2003 with more details. The knowledge of the human genome sequence has created the possibility to investigate functional genomics which tries to describe gene functions and interactions during various conditions such as cancer.

Cancer is a class of diseases in which cells divide uncontrollably, invade adjacent cells or spread throughout the whole body via the blood or lymph. Cancers can be either benign or malignant. Cancers can affect everyone and the risk increases with age, a certain type of lifestyle and environment and if

several cases of cancer had previously been diagnosed within the family. Some environmental factors leading to cancer include tobacco smoking, prolonged exposition to radiations, obesity and pollutants. These factors lead to a mutation in the DNA base sequence resulting in the cells having new properties. Genes are affected in such a way that these new properties now include an excessive growth and cell division, protection against the body's natural immune system, the ability to divide over other cells and into different places. Normal properties, such as the highly specific DNA replication, accurate cell cycle and interactions with the defence system, are lost to the mutated cell.

Cancer can be treated in several ways including surgery, chemotherapy, radiation therapy, immunotherapy and biologic therapy. Depending on the stage the cancer has reached, surgery is performed to remove the cancerous cells or tumour. Usually, after surgery, the cancer patient has to undergo chemotherapy. Chemotherapy is the use of drugs to treat cancer by destroying the cancer cells. These drugs target cells which multiply rapidly. Radiation therapy uses energy to target the damaged DNA. Since cancer cells are sensitive to radiation, they are easily eliminated. However not all types of cancer can be treated though survival rate has increased. Cancer is still the commonest fatal diseases in many parts of the world. Genomics may play an important role in cancer medicine in the recent future. The Cancer Genome Project is using the human genome sequence and mutation detection techniques to identify the mutated base sequence in cancer cells thus mapping the genes responsible for the development of cancer.

Genomic tests or assays are done to identify the specific genes in a cancer cell, which is like identifying a particular fingerprint of the cancer. Although the genomic approach is still being developed, the application of genomic technologies to cancer medicine has already generated promising results both in target identification and in disease classification. Genomics works by evaluating the genes in a sample of cancerous tissue. Genes that have mutated are hence identified along with those which have been inherited. Inherited genes which may lead to cancer are identified by genetic testing. “ Genomics play an important role in helping doctors to determine a patient’s prognosis, which type of cancer it is, to choose the most effective treatment for each individual cancer, to monitor patients who are undergoing treatment to determine if the treatment is working and those who are in remission to catch a potential disease progression early when it is more treatable.”

“ Genomic testing may play an important role in cancer medicine by giving each patient an individualized treatment. Patients with more serious conditions can be identified and offered aggressive and innovative therapies that may prolong their lives, while patients who are diagnosed with a less serious condition may be spared unnecessary treatments. For example, some women with node-negative breast cancer will relapse after being treated with surgery alone. Genomic testing has been shown to differentiate between which node-negative breast cancer patients are more likely to relapse and therefore benefit from additional chemotherapy and which patients may not need chemotherapy. Genomic technology has been applied to several areas of cancer research. By profiling and comparing gene expression of tumours of different grades or primary and metastatic

tumours, several genes involved in cancer progression or metastases have been found, new classification paradigms have been established, genes have been placed into pathways, and gene deletions and amplifications have been identified.”

The application of genomics in cancer medicine will no doubt prove to be beneficial in the long run. The evolution of genomics and its integration in this field is a complex and challenging process. However, progress is being made and instead of treating cancer, cancer could be eliminated before its appearance by modifying the gene responsible. Genomics would also help in improving treatment and diagnosis of cancer. “ The shift from an organ-focused to a gene-focused approach to cancer is already having a profound effect on the way cancer is treated. The impact can be seen particularly clearly in breast cancer. Not too many years ago, breast tumors were categorized and treated primarily by their size, the degree to which they had invaded surrounding tissue or sloughed off cells into the lymph system, and their appearance under a pathologist’s microscope.” The field of cancer genomics is relatively new compared to other fields, however it promises many things. As progress is being made in the mapping of the cancer genes, the results promise to be enormous.