DETERMINANTS ON HEALTH AND THEIR INTERACTIONS GENETIC FACTORS

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Summary

The role of genetics in human health considerations has been of major interest for at least one and a half centuries. Events in the field in the past century culminating in the "breaking" of the genetic code have established at least a twofold relationship to the health of mankind: an increasing knowledge of genetic diseases, their cause, diagnosis and treatment, and that of genetic engineering as applied to humans, plants and animals.
The role of genetics and its relationship to health has become increasingly recognized and important in the past century. Early curiosity regarding the variations in the health and development of humans, plants and animals gave rise to the science of genetics with the observations of plant variation by Mendel in 1865. This work was followed by observations of ethnic groups, closed societies and family groups leading to the recognition of inheritable diseases. The gene was recognized in the early 1900s, followed in mid-century by the discovery that the molecule (DNA) is the genetic material. The description of the structure of DNA in 1953 led to the breaking of the genetic code and the ability deliberately to manipulate genes (genetic engineering).

These developments have resulted in the recognition and classification of genetic diseases. Other health disciplines such as oncology, cardiology and infectious diseases which have a genetic component have also benefited from the application of genetic engineering techniques. New diagnostic procedures and treatment regimes have been, and are, under further development for all of the genetically linked diseases and health conditions. The completion of the Human Genome Project will provide the ability to predict the occurrence of thousands of diseases with a genetic component and increase the options for prevention and treatment.
Genetic engineering applications have also led to benefits in other related health matters. These include the large scale production of proteins for the manufacture of products such as insulin and the human growth hormone. Safer and newer vaccines have been developed. Genetically manipulated plants provide for increased food production and its nutritional quality.

The application of genetics will depend to a great extent upon economics, ethics and legislation. The ethical issues related to ownership of the products of genetic manipulation and the research and development efforts for germ-line therapy give rise to control by restrictive legislation.

1. Genetics and the Gene

Genetics is the scientific study of heredity and variation in organisms. The founder of genetics was the Austrian biologist Gregor Mendel whose experiments with plants were concerned with inherited variation (1865). The physical cause was unknown but by observing variations it could be deduced that there was the existence of a unit that in various forms accounted for the inheritance of different visible traits or characteristics of an organism. This unit or particle was given the name gene by Wilhelm Johannsen in 1909. Prior to Mendel's work it was assumed that the characteristics of the two parents were simply blended. Mendel showed that genes remain intact but their combinations change.

In the 1900s genetics rapidly advanced, first through observation of ethnic groups, societies and families, breeding experiments, and microscopic observations. The science of molecular biology emerged which involved X-ray crystallography to study proteins which led to interest in biological information and its replication. Active connections began in the 1950s when it became clear that DNA was the genetic material. In 1953 James Watson and Francis Crick described the structure of the molecule (DNA) that contains in a chemically coded form all of the information needed to build, control and maintain a living organism ("We have discovered the secret of life", Francis Crick). These discoveries led to the "cracking" of the genetic code and the ability deliberately to manipulate genes (genetic engineering). Since Watson and Crick, the boundaries between biochemistry, genetics, molecular biology and biophysics have become less and less defined.

2. Genetic Diseases

A genetic disease is any pathological disorder or condition caused at least partly by defective genes or chromosomes. In humans there are at least 2,000 genetic diseases

including cleft palate, cystic fibrosis, Down's syndrome, hemophilia, Huntingdon's chorea, some forms of anemia, spina bifida and Tay-Sachs disease.

If the basic cause of the disease is a change in a single gene, it is usually referred to as a mutation and the gene and the person manifesting it as mutant. When the cause is from a disturbance in the number or position of the genes or chromosomes it is referred to as a chromosomal aberration. Genetic diseases may be referred to as (1) simply inherited, (2) chromosomal aberrations, (3) polygenic inheritance, or (4) tumors and cancers.

2.1. A Simply Inherited Disease

Such a disease is one which is attributable to a change in single gene locus. These diseases may be further referred to as autosomal recessive or autosomal dominant. Autosomal recessive is where the affected person has abnormal autosomal genes for the same locus on the chromosomes received from both parents whereas autosomal dominant applies when there is only one abnormal gene at the pertinent autosomal locus.

There are about 650 known simply inherited diseases of varying severity. Most are rare with only one occurrence in 500,000 births or less. Some are common in certain ethnic groups. For example, cystic fibrosis occurs in about one per 2,500 births in persons of Northern European descent, whereas in black populations it occurs in one per 17,000 births and even less in Asians. Tay Sachs disease occurs in about one per 4,000 births in Ashkenazi Jews, contrasted to about 10,000 times this frequency in Sephardic Jews or gentiles.

Some other examples of simply inherited diseases are: hemolytic diseases of the newborn, physical abnormalities, sickle cell anemia, hemophilias, some forms of muscular dystrophy and immuno-deficiencies. Many are not debilitating, such as color blindness and some types of deafness.

2.2. Chromosomal Aberrations

These are divided into two classifications: (1) aberrations of number, the affected individual having more or fewer chromosomes per cell than the normal 23 pairs, or (2) aberrations of chromosome structure, where one or more genes are missing, are present in more than usual numbers per cell or are present in unusual locations. Multiple congenital defects are characteristic of most disorders of this type.

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Biographical Sketch

Vinson Oviatt is an engineer/scientist specializing in the safe control and handling of biological materials and agents. He is a graduate of South Dakota State University (USA) and the University of Michigan (USA). His experience centers around hospital infection control programs with the Michigan Department of Health and the US Public Health Service, laboratory safety applications at the National Institutes of Health, Bethesda, USA and as Coordinator of the Safety Measures in Microbiology program at WHO, Geneva. At WHO he also served as secretary to several scientific groups of the Director General's Advisory Committee on Health Research. He latterly was associated with the Wolfson Institute of Occupational Health, Dundee University Medical School (Scotland).