MODERN GENETIC RESEARCH FOR FUTURE HUMAN SUSTAINANCE: REALITIES AND IMPEDIMENTS

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Abstract

Genetic research has witnessed astronomic revolution since 1866 when the field of study came to focus. Generating from mere morphological studies in a botanical garden in Brunn, Austria, genetics has made giant strides in the field of gene manipulation and recombinant DNA technology, giving rise to genetically modified organisms and genetically modified foods to ensure steady availability of food and animal products for the sustenance of the teeming world human population. The Nigerian state stands to benefit immensely from the numerous discoveries of genetics if notable structures are put in place both at the school front and in industrial circles.

Introduction

Genetics as a branch of science is defined as the modern experimental study of the laws of inheritance, which branches into heredity and variation (Dutta, 1981).It is also noted as a study of the function and behaviour of genes. Geneticists try to find out how the information encoded in genes is used and controlled by cells and how it is transmitted (Microsoft, 2002). Genetic studies date back to 1866, the days of Gregor Mendel (1822-1884) whose scientific discoveries and publications on inheritance in garden peas, coupled with his postulation that characters are determined by discrete 'factors' laid a solid foundation for current research in the field.

It has been noted that in developing countries an abysmally low level of awareness and absolute indifference is shown towards the discipline of genetics. The subject matter of genetics is replete with technical terms which are precursors to better understanding of its fundamental concepts. Most learners often fail to attain an appreciable degree of mastery of the technical terms, and consequently genetics has been branded as a difficult subject – by undergraduates (Johnstone and Mahmoud, 1980 in Okafor, 1990:142) and – by high school science teachers (Finley, Stewart and Yorroch 1982, in Okafor, 1990: 142). As opposed to this, genetic studies in the developed countries have been receiving all the seriousness it deserves, thanks to better enabling environment for learning and research.

Evidence of this abound in major award-winning research reports some of which are summarized below :

Year	Scientist	Discovery
1953	James Watson & Francis Crick	Proposed a molecular structure of DNA
1961-1966	Marshall Nirenberg	The genetic code is deciphered
1972	Paul Berg	Creates the first recombinant DNA molecule.
1977	Walter Gilbert	Devised technique for DNA sequencing
1984	Sir Alec Jeffreys	Developed DNA / genetic fingerprinting
1988		The Human Genome Project begins.
1993		Transgenic sheep used to produce human proteins in their milk. Genetically modified tomatoes go on sale in USA
1997	Ian Wilmut & Colleagues	Announce birth of a lamb (Dolly) – first *I* mammal to be cloned from an adult body cell.
1998	Publication of first complete	sequence of a genome for a complex animal, the nematode Caenohabditis elegans

Source: Abridged from Martin and Hine (2000: 253 -259)

This paper shall review areas of human endeavours where genetic research might be gainfully utilized, highlight some impediments delimiting some research efforts and suggest some ways by which our beloved Nigeria might become a key player in the field of genetic research so that its teeming population can be adequately catered for.

Conceptual evaluation of the aims of genetics in schools and colleges

The scope of genetics as studied in most Nigerian schools entails exposing the learners to mental drills on chromosome structures, the genetic code, gene transmission, gene recombination and simple genetic disorders. Follow-up practical and audio-visual effects are usually lacking in most instructions. Learners therefore find it very difficult to extract meanings from most concepts learned and consequently resort to rote learning so as to pass prescribed examinations. It is therefore crucial that the study of genetics in schools and colleges should be practically built around the life of the learners so that it can be

seen as a rewarding scientific enterprise. This paper therefore posits that given the enabling learning environment, lessons on genetics should be structured on a threshold aimed at exposing learners to:-

i. See the process of cell division as basically a genetic process.
ii. Understand simple genetic disorders and relate them to daily living experiences.
iii. Use knowledge of gene recombination and manipulation in the improvement of plant cultivars and animal breeds for viable consultancy to local farmers and breeders.
iv. Harness the potentials of using genetic resources in improving the health and living conditions of man.

With the actualization of these aims a scholar in the developing countries would be at par with his contemporaries in the developed countries.

Realistic application of genetic knowledge to human endeavours

Crop improvement

In the era of farming in which pesticides and herbicides were extensively used, residues of increased toxicity were often left in ecological food chains and in the soil (Ukpene,1998), to the detriment of secondary consumers. With the initiation of the Integrated Pest Management (IPM) scheme where emphasis is on the use of biological controls, a plant can be made toxic to insect pests. For example, the cloning of a gene which secretes delta toxin of Bacillus thuringiensis into tomato and tobacco results in the death of any insect pest that eats any of the plant parts containing the toxin. Similarly it had been suggested that potato genes when cloned into rice plants can protect the latter from stem borers (Nwagbo, 2004). It is also postulated that through biotechnology research tomato shelf life has been prolonged in the United States by cloning into the tomato a gene resistant to softening in ripe tomatoes. Through hybridization experiments cultivars of cowpea and other arable crops have been successfully developed in Nigeria for disease resistance, early maturity and high yield. Further biotechnology research has equally shown that baking flour could be locally sourced from cassava. Despite these, a lot more still needs to be done.

Animal breeding

According to Storer, Usinger, Stebbins and Nybakken (1979), many useful breeds of domesticated animals such as poultry, and beef cattle such as Hereford, Shorthorn, and Angus have, through selective breeding and perpetuation of mutations produced hybrids that differ remarkably in physical, physiologic and psychological characteristics from their wild ancestors. Through this process also,

table birds such as Plymouth Rocks and Rhode Island Reds with high meat quality, as well as Jersey, a breed of cow with high butterfat have been developed for commercial benefit.

Transgenic experiments

This type of experiment which is currently in vogue in the United States involves the "creation" of whole individuals (transgenic organisms) through genetic engineering. The organisms are created by using suitable vectors to insert the desired foreign gene into the fertilized egg of a host (Martin and Hine, 2000). It was through this process that Genetically Modified Organisms (GMO) and Genetically Modified Foods (GMO) were achieved. While it has been successfully used in plants as well as in culture cells, generating transgenic animals has remained a difficulty. This is partially due to the fact that in generating a transgenic animal, all the cells in the embryo must receive the transgene.

Genetic resources and health care

In the field of health, Nwagbo 2004, and Nicholl 1996, cited that the synthesis of therapeutic protein has made possible the cheap production of growth hormones and vaccines for measles, hepatitis B, polio, cholera, tuberculosis and meningitis from microorganisms such as yeast. It was further asserted that a genetically engineered vaccine against sheep tapeworm, Taenia sp. has been used in Australia and New Zealand with 95 percent efficacy. Human genetics has tremendously enhanced the performance of doctors in their health care delivery programme in which medical practice now focus on keeping people healthy rather than trying to heal them of diseases. Some doctors now use DNA diagnostics (a collection of techniques for characterizing genes) to analyze an individuals DNA for genes that predispose them to some diseases, and then be able to write out a probabilistic health history for some medical condition. As scientists come to understand the complex systems in which disease genes operate, they will be able to design therapeutic drugs to block/and or reverse the effects of mutant genes that cause them. If medication is taken before the onset of diseases, such drugs could prevent occurrence or minimize symptoms of the gene-based diseases.

Reproductive biology also benefits immensely from genetic research outcomes. For example the fertility centre at Port-Harcourt is now using, with high success rate, various Assisted Reproductive Techniques (APT) such as In-vitro Fertilization 9IVF0, Intracytoplasmic Sperm Injection (ICSI) and Pre-implantation Genetic Injection (PGI) to assist couples (hitherto thought to be barren) to have children of their own. However the cost of medication is enormous. Biotechnology research is also available in certain locations in Nigeria

such as IITA Ibadan, National Root Crop Research Institute, Pategi, Cocoa Research Institute Ibadan, Nigerian Oil Palm Research Institute, NIFOR, Edo State.

In addition, the use of Restriction Fragment Length Polymorphisms (RFLP) as genetic markers is being utilized in tracing defective genes such as chromosome 11 for sickle cell anaemia. Once this is traced the defective gene can be replaced with a functional copy that is correctly expressed. As a result the disease caused by the defective gene is prevented. This method of treatment is known as the **gene replacement therapy / gene therapy** (Nicholl, 1996)

Craving for genetically generated 'human spare parts'

The biggest challenge facing world biologists is the proposal to map and sequence the human genome. To this end the Human Genome Project which started in1988 was officially launched in 1990 in the United States of America (Nicholl, 1996). It had been projected that by the year 2005, mapping of the complete human sequence would have been completed. Closely associated with this package was the stem cell research project. (A stem cell is a cell that is not differentiated itself but can undergo unlimited division to form other cells which either remain as stem cell or differentiate to form specialized cells). Many experts believe that embryonic stem cells could lead to new methods of drug discovery, improved scientific understanding of developmental biology and advance the science of tissue and organ transplant (Microsoft, 2002). In 1998 two independent teams, one led by embryologist James A. Thomas of the University of Wisconsin, Madison, using cells of immature human embryos, and the other team led by a geneticist, John Gearhart at the Hopkins School of Medicine, Baltimore, Maryland, using cells from foetuses aborted early in pregnancy, successfully isolated and grew a special kind of cell with capacity to develop into virtually any kind of human tissue.

Before now, little did the world of science realize that the birth of "dolly" in 1997 and the successful cloning of a cow egg and a human egg in 1998, amongst others, were to open up a corridor of ethical, moral and political criticisms that would impede genuine endeavours into human genetic research.

Impediments towards modern genetic researches

Even though the field of genetic engineering and biotechnology are gaining wide acceptance among humanity, geneticists as well as further research efforts are faced with a number of social, moral and political impediments. The Human

Genome Project is one such endeavour that has received so much avowed criticisms. Nicholl (1996:138) writes that:-

> Many people who accept that the genetic manipulation of bacterial, fungal and plant species is beneficial, find difficulty in extending this acceptance when animals (particularly mammals) are involved.

The Human Genome Project is capital intensive and biotechnology companies involved in it may want to recover their huge capital investments by right-protecting their discoveries. On the other hand most people argue on moral grounds that human biological systems should not be patented.

It is also feared that genetic discrimination might be used against some people. For instance, an intending couple may call off an engagement if it is discovered through genetic markers or probes that a spouse has a defective chromosome-11 (for sickle cell anemia) or chromosome -21 (for Down's syndrome) or chromosome-7 (for cystic fibrosis).

The greatest public resentment for the stem cell research was generated in 1998 following the announcement of a successful cloning of a cow egg and an undifferentiated human egg. Till today the United States' congress is still divided in its debate whether to support or reject public funding of the stem cell research.

Conclusion

The field of genetics which has witnessed tremendous growth over the years is presently undergoing a revolution. The Nigerian people stand to benefit immensely from this revolution in terms of genetically modified foods and organ transplant if the government can fraternize with it. However, these benefits will not come easy because given the potential of gene manipulation in areas of basic science, biotechnology, medicine, and space research, the scientific community faces enormous challenge from the public who might not be too willing to relinquish ethical and moral considerations on the threshold of good living derivable from biotechnology research and genetic breakthroughs.

Recommendations

The following recommendations are made in other that the country might benefit from the gains of modern genetic and biotechnology research.

1. College departments which undertake teaching and research in genetics should be empowered through special research grants by government to be

operationally efficient in establishing functional biotechnology research laboratories.

2. Non-governmental Organizations should be encouraged to diversify into biotechnology research in Nigeria. Research outcomes should be patented and subsidized by Government for the benefit of the general populace
3. The government of Nigeria should invite foreign private biotechnology companies to invest in the country. This will assist the country in developing its potentials in the areas of genetically modified foods, as well as reposition it for self sustainance in future tissue and organ transplantation requirements.

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