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Interrelationship of Genetics and Criminal Behaviour : Challenges for Judges and Lawyers

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Introduction

Inquisitiveness of human being to know the mysteries of human physiology leads to the tremendous development of genetic science. Scientists predict that 21st century will be the century of biological science. The outcome of Human Genome Project[1] has largely uncovered the mysteries of our genetic code providing remarkable new insight into the unique human characteristics, which operates at the molecular level. Discoveries in genetics will touch every sphere of human life. New discoveries have far-reaching impact on legal doctrines related to privacy,

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1. Begun formally in 1990, the U.S. Human Genome Project was a 13-year effort coordinated by the U.S. Department of Energy and the National Institutes of Health. The project originally was planned to last 15 years, but rapid technological advances accelerated the completion date to 2003. Project goals were to: (1) *identify* all the approximately 20,000-25,000 genes in human DNA; (2) *determine* the sequences of the 3 billion chemical base pairs that make up human DNA; (3) *store* this information in databases; (4) *improve* tools for data analysis; (5) *transfer* related technologies to the private sector; and (6) *address* the ethical, legal, and social issues (ELSI) that may arise from the project.

   To help achieve these goals, researchers also studied the genetic makeup of several nonhuman organisms. These include the common human gut bacterium *Escherichia coli*, the fruit fly, and the laboratory mouse.

   A unique aspect of the U.S. Human Genome Project is that it was the first large scientific undertaking to address potential ELSI implications arising from project data. Another important feature of the project was the federal government's long-standing dedication to the transfer of technology to the private sector. By licensing technologies to private companies and awarding grants for innovative research, the project catalyzed the multibillion-dollar U.S. biotechnology industry and fostered the development of new medical applications.

   Sequence and analysis of the human genome working draft was published in February 2001 and April 2003 issues of *Nature* and *Science*. See an **index of these papers** and learn more about the **insights gained from them.** Collected from http://www.ornl.gov/sci/techresources/Human_Genome/project/about.shtml

free will, responsibility, autonomy, nondiscrimination and societal opportunities. Judges, lawyers, legislators, researchers, human rights activists--all the people of different countries related to law and associated with justice system should be ready to encounter the future challenges ensuing from genetic development. Ongoing research on genetics and its findings brought many questions before us, in particular it has major bearing on criminal behaviour and criminal justice system. How will law respond to new discoveries in genetics? To what extent the relation between genetics and behaviour affect legal doctrines related to privacy, autonomy, nondiscrimination and societal opportunities? What will happen to the concepts of individual responsibility and free will? If any individual commits crime due to genetically inherited traits, how his/her responsibility will be determined? How s/he will be punished? Should s/he be punished or should they be treated like insane persons without having any criminal responsibility?

In this article an endeavour has been made to find out answers of the above questions. How the researchers, students, teachers and people associated with criminal justice system should respond to the challenges brought by the new discoveries in genetics? Those relevant questions will also be discussed briefly. As genetics is a very advanced branch of human knowledge and scientists of USA have taken leading role to develop this branch of science education, which later on has created the necessity to review some legal doctrines and train up academicians, judges and lawyers to deal with the matters ensuing from this innovative science, so most of the discussion in this article has been made in the context of USA. As all the legal systems, in spite of their differences, have some common elements and as USA belongs to the Common Law Family, with which Bangladesh is also affiliated, so, this discussion will have further bearing for the legal system of Bangladesh as institution, and for judges, lawyers, academicians, and researchers as individuals. Though there is no case so far in Bangladesh where genetics has become determining factor in taking any decision, but the process has been started as national Forensic DNA Profiling Laboratory was set up at the forensic department of Dhaka Medical College Hospital to identify suspected criminals by an analysis of DNA sample collected from the crime scene.

2.1. Heredity and Continuity of life

All the existing species of animal world have to maintain the rules of heredity. From the time of antiquity the facts of heredity were taken for granted. An old proverb says that "like begets like." Human babies usually resemble their parents. Not only human being, all the species of

animal resemble their ancestors in their body shape, size, colour and other characteristics.[2]

Heredity is a common phenomenon known to everyone, nevertheless, it took long time to understand essential facts of heredity. Mythical stories stated that human beings arose from animals, trees, or stones and men were turned into natural objects. Even Aristotle accepted the general belief of his time that plants and complex animals like fleas, mosquitoes, and snails arise spontaneously from decaying matters. Belief in spontaneous generation withered away after a succession of brilliant and subtle experiments. Finally Louis Pasteur (1822-1895) established that the spark of life could be kindled only by life itself. Spallanzani, Pasteur, and their followers proved that heredity and living matter are coextensive. Existence of one certainly presupposes the existence of other. In all organisms like begets like. "This meant that all organisms, from bacteria to man (human) reproduce themselves by converting materials taken from the environment- food into the living stuff of their own bodies. Heredity in the last analysis, is self-reproduction, the common property of all life and the property that distinguishes living from non-living matter."[3]

All the existing living organisms evidence the unbroken continuity of life and uninterrupted succession of living beings in this earth. In the mists of the remote past the actual origin of life was lost. But the fossil record of ancient times proved that the animal and plants of today are direct lineal descendants of earlier organisms. All the living organisms grow old and die, so the continuity of life is maintained by the transmission of heredity to their offspring through a process of reproduction. Among plants and animals the reproduction is sexual presupposing the union of two sex cells, or gametes, which form a single cell or zygote. A new living organism develops from this zygote. So, a physical link between parents and the offspring exist both in sexual and asexual reproduction. A part of the parents grows and later develops and it will become the body of the offspring.[4] So, living species, including human being, resemble their parents in their physical disposition, mannerism and in their traits.

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2. Edmund W. Sinnott, L.C. DUNN, and Theodosius Dobzhansky, *Principles of Genetics*,Tata Mcgraw-Hill Publishing Co. Ltd., New Delhi, Tenth Reprint, 1981, p. 1.
3. *Ibid*, p. 2.
4. *Ibid*, pp. 3-5.

2.2. Development of Genetics[5]

There are three branches of the study of genetics, transmission genetics, molecular genetics and population genetics. Transmission genetics studies the transmission of traits from one generation to the next. Molecular genetics studies the subject from its fundamental base, molecules. This study is concerned with the molecules that constitute genes, the molecules that control genes and the molecules that are the products of genes. This branch of genetics studies the structure and expression of genes at the molecular level. Population genetics visualize the genetic differences between species and studies the variation of genes between and within populations.[6]

Chromosome means any of the tiny parts like threads in animal and plant cells, carrying genetic information on the particular characteristics that each animal or plant will have.[7] Chromosomes are the discrete physical entities that carry the genes. A mixture of compounds in the cell nucleus was discovered in 1869 which is called nuclein. Deoxyribonucleic acid (DNA) is the major component of nuclein. Chemists got idea of the general structure of DNA and of a related compound, rebonucleic acid (RNA) by the end of nineteenth century. Both are chains of small compounds called nucleotide. Each nucleotide is composed of a sugar, a phosphate group and a base. Linking the sugars to one another through their phosphate groups the chain is usually formed.[8]

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5. For proper understanding of human genetics everyone must have knowledge of Gene, DNA, Protein and Cell.

   Gene : The Unit of inheritance located in a chromosome which is transmitted from one generation to another in the gametes and controls the development of a character in the new individual. In other words it is a region of DNA.

   DNA : DNA is the genetic material or chemical that stores coded information on how, when and where an organism should make the many thousands of different proteins required for life.

   Protein : All living organisms are made up largely of proteins, which provide the structural components of all our cells and tissues as well as specialized enzymes for all essential chemical reactions. Through these proteins our genes determine how well we process foods, detoxify poisons and respond to infections. It is true workhorses of all our trillions of cells.

   Cell : The basic structural and functional unit of life.

6. Robert F. Weaver, and Philip W. Hedrick, *Basic Genetics*, Wm. C. Brown Communications, Inc. 1995, p. 10, 17.

7. *Oxford Advanced Learner's Dictionary*, 1999, p. 197.

8. *Supra* note 6, pp. 11, 14.

Chromosome is composed of a string of genes and DNA comprised the genes. Genes exist in a linear array on chromosomes. Each gene carries the information for making one polypeptide chain (a single protein chain is often called a polypeptide.) Most genes are made of double stranded DNA arranged in a double helix. They are complimentary of each other. The information for making an RNA is carried by the linear sequence of basis in a gene. It contains the information for making a protein chain. The protein product may be changed by a mutation (change) in this sequence. There are various activities, which come within the domain of genes. First, they are replicated faithfully. Secondly, the production of RNAs and proteins are being directed by the genes Thirdly, genes accumulate mutations and thus paving the way for evolution.[9]

Like a twisted ladder a DNA molecule consists of two ribbon-like strands that wrap around each other. In humans and other higher organisms DNA constitution is similar. The ladder rungs are made up of chemicals called bases, abbreviated as A. T. C and G. Each rung has a pair of bases, it is either A and T or C and G. There are three billion base pairs (six billion bases) of DNA in most of the human cells, this is called human genome. The sequence of bases is different for everyone and that makes every human unique. Due to the impact of environment and the variation in base sequence, we observe diversity among humans. The complete human genome is packaged into 46 pieces of DNA called chromosomes. Every human gets 23 pairs of chromosomes from his/her parents. In trillions of human cells a complete set of 46 chromosomes are found. Among the 23 pairs 22 are identical, one is different which determines sex of a child, Females receive an X from each parent (XX) and males get X from mother and Y from father (XY).[10] "A genetic map of the human genome is a map of the chromosomes having polymorphic DNA markers at determined intervals. A polymorphism means that different sequences of DNA are found in the population at the same locus. The utility of such a map is to facilitate the localization of disease and the behaviour genes by family-linkage and the population studies."[11]

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9. Ibid, pp. 14-17.

10. Denise Casey, "What Can the New Gene Test Tell Us?", *The Judges' Journal of the American Bar Association*, Summer 1997, Vol. 36: 3, pp. 2, 3. Internet version of the article. 15 September 2005.

    <http://www.ornl.gov/sci/techresources/Human_Genome/publicat/judges/judge.htnl>.

11. Hoffman, Am J Hum Gen, 54:129 (1994); Marshall, Science, 274:488 (1996); Lander, Science, 274: 536 (1996).

    Internet version. *<www.biojuris.com>*.

2.3. Behaviour and Genetics

There are two types of behaviour, instinctual behaviour and learning behaviour. Instinctual behaviour is acquired by birth, genes are basis of this kind of behaviour. In animal world hereditary characteristics are transmitted from parents to their offspring. High degree of instinctual behaviour is seen among the mammals. Learning behaviour is developed in interaction with surrounding milieu and outer world. Instinct and environment together have accumulated impact on human behaviour. The variation in human behaviour is heavily contributed to by genetic and environment factors. How far genes and environment influence the commission of criminal activity -- that has become a fascinating subject to be enquired into by the inquisitive mind of human.

2.4. Heredity and Environment

Each offspring gets single gametic nucleus from its parents which is too small to be seen by an unaided eye. Nevertheless this is the only physical link between parents and offspring and everything is transmitted from one generation to the next across it. A new individual develops out of a particle of parental body and then undergoes growth. An individual's body is about fifty billion times greater than that of the fertilized egg from which it developed. The enormous increase that has been occasioned to the mass is due to the food the organism consumes. Organic and inorganic foods incorporated into the body cause growth of a living organism. " The parental organism reproduces itself in its offspring by organizing in its own peculiar way the materials taken from the environment. The essence heredity is thus self-reproduction of the organism at the expense of the environment."[12]

Heredity of a living organism continuously interacts with environment. The development of that organism at present and future is determined by this interaction. In 1911 Danish Geneticist Johannsen proposed to distinguish the 'genotype' of the organism from its 'phenotype'. " The genotype is the sum total of heredity, the genetic constitution that an organism receives from its parents. The 'phenotype' is the appearance of the organism- the sum total of all its characteristics, such as colour, form, size, behaviour, chemical composition, and structure, both external and internal, gross and microscopic."[13]

Individual entity of any species of animal or plant is recognised by their 'phenotype's. With the advancement of time 'phenotype' is changing.

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12. *Supra* note 2, pp. 17-18.

13. *Ibid.*, p. 18.

For that reason physiological changes constantly occur in an individual. It is witnessed by a series of photographs of a person taken at different ages from childhood to old age. 'Genotype', in contrast to the 'phenotype', is relatively stable thoroughout the whole life of an individual. From infancy to senility an individual has similar genes. What 'genotype' an individual possesses that can be identified by observing its impact on the 'phenotype' and by studying the ancestry. If two or more individuals have been nurtured in similar environment, but their 'phenotype's are different, then the conclusion will be inevitably that they possess different 'genotypes'. On the other hand, individuals having similar 'genotype's when grow in different environment, their 'phenotype's may be quite different.[14]

The environment in which organisms have been nurtured is never the same in different places and at different times. For this reason no two individuals are ever exactly alike. Two plants growing side by side cannot receive the same amount of light, water and minerals. The quantity and quality of food consumed by two animals differ at the same stage of development. When two individuals having same 'genotype' encounter different conditions of food, temperature, light, humidity and other external factors, then their 'phenotype' will be different. Organisms of similar heredity when experience this sort of differences, those are called environmental variations or modifications.[15]

Except identical twins, no two persons are likely to possess similar 'genotype', which is called hereditary, or genotypic variation. The elements responsible for heredity and genes when undergo changes, that is known as mutations and those result in genotypic variation. The changed gene may then be entered into a variety of combinations with other changed or unchanged genes, which gives rise to genotypic variation. Likeness of heredity (like begets like) and variation both have universal application, but likeness does not mean complete similarity. Different aspects of heredity and variation have been focused by geneticists. The causes of similarities and of the dissimilarities between the developmental patterns of different organisms are studied by geneticists.[16]

Which is more important-- heredity or environment? This type of question is meaningless in the sense that both are necessary and important. The 'genotype' of any organism through an interaction with the environment produces 'phenotype'. Thus an individual is a product of

14. *Ibid.*,pp. 18-19.

15. *Ibid.*, p. 19.

16. *Ibid.*, p. 19.

growth and development brought about by a 'genotype' in a certain atmosphere. The environment of a particular moment does not determine 'phenotype' of a person at a given moment, rather the whole succession of environments that individual has experienced during his/her lifetime determines his/her 'phenotype'. Thus every individual has become product of his/her 'genotype' and life experiences.[17]

3. Interrelationship between Gene and Criminal Behaviour

The common sense observation that children resemble their parents in appearance and mannerism reveals the fact that people tended to explain human behaviour in terms of heredity from ancient time. Scientific theories of heredity originated around 1850. Francis Galton and Karl Pearson used new statistical methods to measure degrees of resemblance. When conducting studies on criminals, Charles Goring utilized the new statistical techniques. He concluded that crime is inherited like other physical traits and features.[18] This type of biological determinism did not get much support, leaving the nature versus nurture debate to continue.

Which is responsible—gene or environment—behind the commission of criminal activity? From a number of twin, family, adoption studies and laboratory experiments, it is evident that both genes and environment play a role in the criminality of an individual. An interaction between genes and enviornment makes criminal behaviour more predictable. If genetic predisposition gets favourable environment, the possibility of criminal or anti-social behaviour will be more.

In the late nineteenth and early twentieth centuries, researchers believed that genes were fully responsible for crime, which led sterilization to rid society of criminals and anti-social actors. The same question has been resonated again, as some psychological problems have been shown to be heritable, and in favourable circumstances it may set the individual to commit crime. What should be the role of the society? Should it limit the reproductive capabilities of individuals who suffer from certain psychological problems?[19]

Whether genetics play a role in anti-social or criminal behaviour is debatable. To understand the debate one must first look at the available studies. In twin studies monozygotic (MZ) or identical twins and their

17. *Ibid.*, p. 19.

18. George B. Vold, Thomas J. Bernard and Jeffrey B. Snipes, *Theoretical Criminology*, Fifth Edition, Oxford University Press, New York, 2002, pp. 38-39.

19. Caitlin M. Jones, "Genetic and Environmental Influences on Criminal Behaviour," Winner of 2005 RIT Kearse Award for Writing, Rochester Institute of Technology, pp. 1-2.

rates of criminal behaviour are compared with the rates of criminal behaviour of dizygotic (DZ) or fraternal twins. Genetic influence on the criminal behaviour can be assumed if the studies show a higher concordance rate for MZ twins than for DZ twins.[20] In a study conducted on 32 MZ twins who were reared apart, high degree of heritability was found in childhood and aduit antisocial behaviour. Another researcher studied 85 MZ and 147 DZ pairs and found that the concordance rate for the MZ pairs was higher. In another study two researchers studied 49 MZ and 89 DZ pairs and concluded that hereditary factors had very little contribution to the commission of crime.[21] The limitation of twin studies is that the validity of those studies and their ability to separate the nature and nurture aspect has been questioned. It necessitated the examination of other information.[22]

Adoption studies are important as those attempted to separate nature and nurture aspects of human behaviour. How far an adoptive child is influenced by the genetic traits of his/her biological parents, and how far by surrounding environment—that could be determined by the behaviour disorder of an adoptive child. All the adoption studies conducted in Iowa, Sweden and Denmark lend support to the proposition that there may be a genetic component to antisocial or criminal behaviour, but specifically pointing property offences, not for violent crime.[23]

In the field of family studies some research were conducted in the late nineteenth and early twentieth centuries. After a long gap some researchers became again interested in family study in the last decade of twentieth century. Robert Dugdale conducted a study on generations of an American family and his findings was published in 1877 under the title "The Jukes". He collected information about 1000 descendants of Ada Jukes (a pseudonym) and found 280 paupers, 60 thieves, 7 murderers, 140 criminals, 40 venereal disease victims, 50 prostitutes and other deviants. He claimed this case study as an example of inherited criminality. Henry Goddard conducted a similar case study and it was published in 1912 in his "The Kallikak Family". One Martin Kallikak "fathered a child out of wedlock to a 'feebleminded barwench', a large number of the descendants of whom were feebleminded, or deviant". Kallikak's

20. Tehrani and Mednick, S., "Genetic Factors and Criminal Behavior," *Federal Probation*, 64, 2000, pp. 24-28.

21. Jay Joseph, "Is crime in the genes? A critical review of twin and adoption studies of criminality and anti-social behavior," *The Journal of Mind and Behavior*, 22, 2001, pp. 179-218.

22. Supra note 19.

23. Supra note 21.

marriage to a respectable woman gave birth to offspring of the highest moral and mental standard, which Goddard took as a proof of the relation between heredity and crime.[24]

Bruner, Nelen, Breakfield, Ropers and Van Oost (1993) conducted a study on a large Dutch family. They found that a number of males of that family had a neurochemical in their brain which was associated with aggressive criminal behaviour.[25] Research in the field of family study is probably least accepted as it is very difficult to separate nature and nurture aspect of human behaviour in those studies. Three family studies within a time span of more than 100 years are not sufficcient to draw the conclusion that genetics play an important role in antisocial or criminal behaviour.

There are some neurochemicals, namely—monoamine oxidase (MAO), epinephrine, norepinephrine, serotonin, and dopamine—alleged to influence criminal or antisocial behaviour. Monoamine oxidase is an enzyme which has been shown to be related to antisocial behaviour, particularly low or deficiencies in MAO activity results in disinhibition leading to impulsivity and aggression.[26] Serotonin plays an important role in the personality traits of depression, anxiety, and bipolar disorder.[27] Low levels of serotonin are found to be linked with impulsive behaviour and emotional aggression. Dopamine is a neurotransmitter which is associated with pleasure and also with aggression.[28] This list of neurochemicals lend support to the proposition that there may be a genetic component to antisocial or criminal behaviour.[29]

4. Chromosomal Abnormality

Chromosomes are the basic structures that contain our genes. Each individual gets 23 pairs of chromosomes from their parents, one pair

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24. Frank E. Hagan, *Introduction to Criminology: Theories, Methods, and Criminal Behaviour*, Nelso-Hall, Chicago, USA, 1989, p. 409.
25. J. Alper, "Biological influence on criminal behaviour: How good is the evidence?" *British Medical Journal*, 310, 1995, pp. 272-273.
26. F. A. Elliot, "A Neurological perspective of violent behavior," in D. H. Fishbein, ed., *The science, treatment, and prevention of antisocial behaviors: Application to the criminal justice system*, NJ: Civic Research Institute, Kingston, 2000, pp. 19-21.
27. R. J. Larsen and D. M. Buss, *Personality psychology: Domains of knowledge about human nature*, Second Edition, New York:McGraw-Hill, 2005.
28. Supra note 26.
29. Supra note 19.

determines gender. A female gets an X chromosome from mother, and another X from father; a male receives X from mother and Y from father. Each ovum or a sperm bears 23 chromosomes at conception and join together to form a single cell. It will then develop into the embryo. Sometimes an abnormal cell division takes place before conception and the sperm or ovum contains more than one sex chromosome. The resulting embryo will then get an extra sex chromosome. XXY individual, known as Klinefelter's syndrome, was the first to be identified as having sex chromosome abnormalities, which is claimed to be related to degeneration of the testes, sterility, breast enlargement, moderate metal retardation, alcoholism and homosexuality. It is to be mentioned that the findings related to Klinefelter's syndrome are widely disputed.[30]

Sometimes because of the defect in the production of sperm or egg, some males get an extra Y chromosome, which abnormality is designated as the XYY syndrome. Approximately 1 out of 1000 newborn males takes birth with this genetic composition.[31] Patricia Jacobs was the first to investigate whether XYY males have any tendency to aggressive behaviour. She did it in maximum security mental hospital in Scotland.[32] In the subnormal wing of the hospital, she found 12 out of 196 men had chromosomal abnormalities, including 7 with XYY abnormality, who were exceptionally tall. Jacobs and her colleagues described XYY males as dangerous and violent. It was substantiated by the fact that some violent crimes were committed by males who were later found to have XYY abnormality. But further investigations revealed that XYY inmates were considerably less violent than other inmates. Researchers in some studies concluded that XYY males were not predictably aggressive. No researcher conclusively tells that males having XYY abnormality will be criminals, rather an increased risk of developing an anti social personality has been argued.[33]

The XYY abnormality drew much public attention because of the case of Richard Speck. In 1966 Speck killed 8 nurses in Chicago. He was initially diagnosed as having XYY syndrome, but later diagnosis proved it wrong. Nevertheless the question was frequently asked: Were all XYY

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30. George B. Vold, *Theoretical Criminology*, Second Edition, Oxford University Press, New York, 1979, pp. 116, 117.

31. Sarnoff A. Mednick, Terrie E. Moffitt, and Susan A. Stack, *The Causes of Crime: New Biological Approaches*, Cambridge University Press, New York, 1987.

32. P.A. Jacobs, M. Brunton, and M. M. Melville, "Aggressive Behaviour, Mental Subnormalty and the XYY Male," *Nature*, 208, December, 1965, pp. 1351-52.

33. *Supra* note 30, pp. 117, 118.

males potential murderers? Since that time investigations were undertaken to examine the relation between XYY abnormality and criminality, but researchers did not find any convincing evidence. Nevertheless, there is possibility that violent behaviour may be partly determined by genetic factors. But it is difficult to investigate the possibility. One major problem is to separate genetic predispositions from environmental factors, which include family, culture, socioeconomic status, and peer influences. An individual may have genetic predisposition to aggressive behaviour, but as he was born and brought up in a good family environment, and got education and ethical lesson, he may never commit a delinquent act. Another person may possess a genetic predisposition to law-abiding and gentle life. But because of bad family atmosphere and poor education he may commit crime. It is very difficult, then, to determine to what extent behaviour is influenced by genetics?[34]

5. Law and Genetically Induced Criminal Behaviour

Genetics has enormous utility in criminal law. In rape cases it is used for identifying defendants. It is also used as a defence to exculpate or provide mitigating reasons for a crime. When any guilty act is committed in pursuance of a culpable intent (*mens rea*), that act is punishable in criminal law. Without a criminal state of mind, criminal liability is rarely imposed. The rationale behind the theories of punishment is that the threat of penalty will deter criminals. An individual acting without knowledge or intent remains beyond the deterrent effect of law. If any defendant in a criminal case makes a mistake of fact or law, what will happen? Ignorance or mistake of fact or law is a defence under a Model Penal Code[35] when it negates the *mens rea*, which can be inferred from negligent and reckless behaviour. A criminal defendant is said to possess culpable state of mind if he knowingly disregards a grave and unjustifiable risk.

If any person has any genetic disease which is responsible for his criminal behaviour, should that person be held responsible for the crime? His attorney may plead that he did not have *mens rea*. The attorney may call a geneticist to substantiate his defence. If the geneticist argues that the offender was not in a conscious state of mind and he did not commit the offence voluntarily, how the judge will respond?[36]

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34. Freda Adler, Cerhard O. W. Mueller, and William S. Laufer, *Criminology: The Shorter Version*, Second Edition, McGraw-Hill, Inc., USA, 1995, p. 92.

35. A Model Penal Code is a Code which contains some basic features that are expected to be ideal and to be followed in different countries for defining which activities constitute crime and deserve punishment.

36. "Criminal Genes and the Law". 24 January 2003. <*http://www.biojuris.com/crimlaw01.htm*>.

In the above case, some very crucial questions have been raised in the context of numerous links between gene and behaviour. Human genes are responsible for variation in human behaviour including aggression, anxiety and depression. If one's genes control his/her behaviour, ho criminal justice system will cope with these facts? Under the criminal law a person is punishable, when s/he commits any offence voluntarily with guilty intention. If it is proved that a particular gene is responsible for a defendant's violent behaviour, how the criminal justice system will respond? Is it fair to hold that person accountable for his/her violent activities? Are the violent activities outcome of direct and voluntary action on the part of the accused? Or is it emotional outburst of the accused? Or do criminal genes compel the accused to commit punishable activities? "A more reasonable formulation may ask what the probability is that an individual with a particular 'genotype' will lead to criminal conduct. If it is 100%, do we let him off on the grounds that either the act was not voluntary or he could not have possessed *mens rea* because of the genetic defect? If the defect only establishes a propensity to criminal activity, say 20%, then should his punishment be adjusted accordingly?"[37]

Principle of criminal responsibility has some exceptions. Children and mentally disordered persons are kept beyond the framework of punishment, because they are incapable to understand the consequences of criminal activity. Even deterrent effect of punishment is quite useless for them. Now question comes, whether people having behaviour disorder caused by their genes should be treated like child and insane persons, who are devoid of criminal responsibility?

A woman sought help of Dr. Han G. Brunner, a medical geneticist, for a problem in her family.[38] Many males of her family for generations had been prone to violent and unprovoked aggressive activities. Information collected about the matter of the family revealed that nine of them exhibited aberrant and violent behaviour. One of such males was convicted of the rape of his sister, another attempted to run his boss over with a car, another would enter his sisters' bedrooms at night and force them to undress. Two of the family members were convicted arsonists. DNA analysis of tissue samples of 24 members of the family was made by Brunner and his colleagues. They identified a DNA marker on the X-chromosome among the affected males, but unaffected males did not have this DNA marker.[39] In *Turpin V Mobley*[40] it was revealed that last

37. *Ibid.*

38. This is a study of Dutch family in the Netherlands and referred to in *Stephen A. Mobley V. The State*, 265 Ga. 292; 455 S.E. 2d 61 (Supreme Court of Georgia 1995).

39. *Ibid.* The author of the report referred to in Mobley case was Dr. Han G. Brunner.

40. 269 Ga 635; 502 S. E. 2d 458 (Supreme Court of Georgia, 1998).

three generations of the Mobley family had exhibited aggressive and antisocial behaviour. These people included a murderer, a rapist, an armed robber, several substance abusers, and several spouse abusers.

6. Behavioural Genetics and Law

Behavioural genetic determinism has grave social, legal and ethical consequences. Mark A. Rothstein[41] has discussed the effects of genetics on many areas of law, including employment, insurance, commercial transactions, civil litigation and privacy. He has discussed general principles of law that help to frame the issues of behavioural genetics and law.

6. 1. Unitary Standard of Legal Duty

The lawfulness of an individual's conduct is determined with reference to the standard behaviour of a reasonable person both in civil and criminal cases. The activities of plaintiff and defendant are evaluated in terms of whether it conforms to the standard of a reasonably prudent person under similar circumstances. Whether a person of average rationality could have done the same thing that is testified with the help of unitary 'reasonable person' standard.[42]

Reasonable person standard implies that it is not possible to determine the precise cognitive, physical, or behavioural abilities of the individuals in any legal proceedings. Nevertheless, suppose precise evaluation of individual characteristics were possible and an expert witness were prepared to testify about the innate capability of an individual in a case, civil or criminal. Would this matter? Should it? According to Dan Brock, a philosopher, "If a person's genetic structure is a principal cause of behaviour and that genetic structure is completely beyond the individual's control, can an individual justifiably be held responsible for the resultant behaviour?"[43] A significant change in the law's view of the bounds of individual conduct would be made, if the unitary standard were replaced with a more subjective standard.[44]

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41. Mark A. Rothstein, "The Impact of Behavioural Genetics on the Law and the Courts," *Judicature genes and Justice*, November-December, 1999, Vol 83 (3). Internet version. 15 September 2005.

    <http://www.ornl.gov/sci/techresources/Human_Genome/publicat/judicature/article5.html>.

42. *Ibid.*

43. Quoted in *ibid.* See Brock, The Human Genome Project and Human Identity, 29 Hou. L. Rev. 7, 16 (1992).

44. *Supra* note 41.

6. 2. Impact of Behavioural Genetics on Adversary System

Adversary system is characterized by partisan presentation of the evidence, a passive judge, a neutral jury and a structured trial format. Under this system the truth is not determined by the lawyers, but by the judge or jury. Lawyers' role is to be zealous advocacy on behalf of their clients. Presentation of exact evidence and cross-examination of witnesses finally uncover the truth. The advocates of both sides put forward all possible arguments on behalf of their clients. Professional ethics require the lawyers to be zealous advocates. Lawyer should utilize the legal procedure for the fullest benefit of the client. Lawyers are expected to give every possible argument, no matter how weak it may be, in favour of their client, particularly in criminal cases. Defendants are given even wider leeway in submitting mitigating evidence during sentencing phase of a criminal case. "Zealous advocacy" principle in criminal cases put forward innovative scientific assertions. In 12 US cases mothers were accused of murdering their infants and post-partum psychosis was argued as defence. The women received light sentences or were found not guilty. Post traumatic stress syndrome and premenstrual syndrome were argued as defence.[45] Sometimes in some notorious killings the convicted got lesser sentence because of innovative scientific assertions which kindled severe criticism.[46]

In civil cases, such as personal injury litigation, plaintiffs encounter difficult time as they cannot prove whether the injury was caused by the unlawful act of the defendant. Because of innovative scientific discoveries "junk science" or "liability science" has emerged. Scientific experts have pushed the frontiers of scientific thinking in favour of defendants. They assert, for instance, that a particular environmental exposure, pharmaceutical product, or medical device resulted in a particular injury to the plaintiff. "Because of the adversary system, it is virtually certain that parties in both criminal and civil cases will assert behavioural genetic arguments well before there is general support for such views in the scientific community. These arguments are particularly appealing in criminal cases because they can be used to prove that defendant was compelled to commit the act by uncontrollable genetic factors."[47]

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45. *Ibid.*

46. For many individuals, the zealous advocacy standard for presenting novel defences was stretched to the breaking point by the "Twinkie defense" in the murder trial of Dan White, a former San Francisco supervisor charged with murdering Mayor George Moscone and supervisor Harvey Milk in 1978. At trial, forensic psychiatrist Dr. Martin Blinder, then an assistant clinical professor at the University of San Francisco Medical School, testified that the junk food eaten by White could have affected his decision to shoot the victims. After White was convicted merely of voluntary manslaughter, the California Legislature amended the penal code to limit defence attorney's right to offer such evidence.

47. *Supra* note 41.

6. 3. Genetics and Risk-Averse Behaviour

Behaviour genetic information could lead to a wide range of risk-averse actions. *Carlsen V. Wackenhut Corp.*[48] is a good illustration of such a case. In 1994 at a Bon Jovi rock concert a security guard attempted to rape a 16-year old patron under the stands. The security company that employed the guard was then sued by the girl for negligent hiring. She alleged that the company should have enquired into the background of the security guard before employment. The company would, then, discovered that the man had four prior convictions, including one for second degree robbery. The appellate court reversed the trials court's summary judgment for the company and held that upon discovery of a prior robbery conviction, a prospective employee had a tendency to commit criminal activities.[49]

From the above case a number of questions emerge. Would the employers in the future will be put under an obligation to review medical records or make their own medical arrangement to test whether applicants had genetic indicators of an increased risk for violent behaviour? Would it transgress Disabilities Act or other laws of USA?

6. 4. Genetic Information and Medical Privacy

With the development of individualism, right to privacy has taken hold. The recognition of a legal right to privacy is largely a twentieth-century phenomenon. The privacy and confidentiality of medical information has not been afforded adequate protection in any of these areas. The federal constitutional right (of USA) to privacy has been used to restrict the government from interfering with personal medical decisions, such as providing and withholding medical treatment, procreation, contraception and abortion. In serious problems like drug abuse or other problems related to health of the people, government can interfere. In *Whalen V. Roe*, 1977, the Supreme Court unanimously held that, "Disclosures of private medical information to doctors, to hospital personnel, to insurance companies, and to public health agencies are often an essential part of modern medical practice even when the disclosure may reflect unfavourably on the character of the patient. Requiring such disclosures to representatives of the State having responsibility for the health of the community, does not automatically amount to an impermissible invasion of privacy."[50]

In *Young V. Jackson*, 1990, in a nuclear power plant rumours spread that the reason for an employee's illness was radiation exposure, as a result work was disrupted in the power plant. A Mississippi court held that the employer had privilege to disclose the fact. Employer had the right to tell employees that the plaintiff was ill due to the effects of a hysterectomy.[51]

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48. SC. 843; NY 421, 1994
49. *Ibid.*
50. *Supra* note 41.
51. *Ibid.*

To protect the privacy of genetic information Oregon enacted the nation's first state law in 1995. "Subject to various exceptions, the law provides, among other things, that no person may obtain genetic information from an individual without informed consent, no person may retain genetic information without obtaining specific authorization, and no person may disclose genetic information without specific authorization. A similar 'procedural' law has been enacted in California."[52] The laws only prohibit the unauthorized collection, retention, or disclosure of genetic information. There are many instances where law has nothing to do in which individuals are needed to give genetic or other medical information as a condition of employment, insurance, education, commercial transactions and other matters. Behavioural genetic information will not get better privacy protection than other types of medical or genetic information. Some overtly intrusive inquiries or unnecessarily extensive disclosures may be limited by constitutional, statutory, or common law theories. To safeguard the privacy of genetic information a wide range of substantive limitations in each specific area will require to be enacted.[53]

7. Challenges for Judges and Lawyers

Not only genetics, spectacular development in different branches of science has created multifarious implications for law. Scientific inventions require proper legislation for their smooth regulation on the one hand, resolution of those matters, touching and creating complicacy in human life, by the court on the other. At the threshold of twenty first century the inter-dependence between law and science is expanding. The people associated with legal and scientific arena are developing extensive interrelations. Without this interrelation and interdependence both law and science cannot square with the exigency of time. In Judicature, Justice Stephen Breyer very eloquently underlines the inter-dependence of science and law and writes[54] that "law itself increasingly needs access to sound science" and that scientifically complex technology "increasingly underlies legal issues of importance to all of us." Justice Breyer reminds us that "a judge is not a scientist and a courtroom is not a scientific laboratory," but that, " to do our legal job properly we [need] to develop an informed, though necessarily approximate, understanding of the state of... relevant scientific art."[55]

The aim of Human Genome Project, formally started in 1990, is to identify the estimated 3 thousand or more human genes and determine the sequence of 3 billion base pairs. Due to the tremendous progress,

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52. *Ibid.*

53. *Ibid.*

54. *Judicature*, July-August, 1998.

55. Quoted in Reagan Dey, "Impact of Human Genetics on Criminal Behaviour and Criminal Justice System," *Journal of Law*, Vol. 1, No. 1, June, 2003, p. 9. See Sherman, "Junk Science" Rule used Broadly; Judges Learning Daubert, Natl. L.J., Oct. 4. 1998, p. 6.

Human Genome Project nears completion. This titanic development in genetics has created heavy implication on legal system.[56]

US experience underlines the role of judges, who need to develop expertise to verify the reliability of scientific evidence and its utilization in taking legal decisions, specifically in criminal cases. Lawyers are increasingly tended to present mitigating reasons to exculpate their clients with reference to new discoveries of genetics. Modification of legal principles and making of new laws are suggested in the context of increased inter-dependence between law and genetics.

Adversary system encourages lawyers' zealous advocacy, which further encourages the lawyers to utilize unproven scientific theories in their clients favour. The next important question is how will judges [and juries] consider this evidence? From the available data it is clear that both judges [and juries] are ill-prepared to evaluate the validity of novel scientific assertions. And the juries have a tendency to give much credence to arguments based on novel scientific discoveries. Regarding scientific evidence the initial problem is faced by the lawyers as they have to persuade the court to view the evidence admissible. This question was once settled in US in 1923 in *Frye V. United States*.[57] In this influential case the court held that scientific evidence is admissible if it is generally accepted as valid by the scientific community.

The Frye-test lasted for 70 years, until it was replaced in 1993 by a Supreme Court decision in *Daubert V. Merrell Dow Pharmaceuticals, Inc.*[58] The court held that Frye principle was inconsistent with Federal Rules of Evidence. Under the Federal Rules, judges cannot defer to the scientific community's acceptance of the evidence in question. To determine the reliability and probative value of the evidence judges are needed to make an independent judgment. Judges must determine "Whether the reasoning or methodology underlying the testimony is scientifically valid." "This is composed of four factors: (1) whether the theory or techniques can be or have been tested; (2) the extent to which there has been peer review and publication of the theory or techniques; (3) the known or potential error rate and the existence and maintenance of standards controlling the technique's operation; and (4) the general acceptance of the methodology or technique in the scientific community."[59]

In spite of disagreement among judges and scholars, Daubert principle, at least in theory, made it easier to get scientific evidence admissible into court. But for trial court judges undoubtedly Daubert made things more difficult. State and federal court administrators have started programs of

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56. Reagan Dey, "Impact of Human Genetics on Criminal Behaviour and Criminal Justice System," *Journal of Law*, Vol. 1, No. 1, June, 2003, pp. 3-14.

57. 6 B & S. 456 NY

58. L.R. & SC 764 CA

59. *Supra* note 41.

scientific education and publication of manuals on scientific evidence to increase the scientific acumen of judges.[60]

Lawyers under the adversary system have a tendency to introduce insufficiently tested scientific evidence. Judges, who do not have scientific expertise, must decide what methodology and theories have valid scientific basis. Courts are increasingly admitting novel scientific evidence and juries often give great credence to scientific evidence.

Daubert principle put the judges in a place to play the role of a gatekeeper, hence they require scientific knowledge to scrutinize scientific evidence. Claire L. Heureux-Dube[61] very correctly noted that "the law cannot lag behind science; in the best case scenario they will complement each other and thus serve the public interest optimally and for this they need adequate scientific knowledge"[62] Daubert standard requires the judges to screen expert testimony, due to very sound rationale that lay jurors when determining the truth may be adversely influenced, if they are exposed to unscrutinized scientific testimony.[63]

In the context of tremendous genetic development, judges require special science education to understand complex cases and adjudicate the matter to promote the cause of justice. Workshops, conferences, seminars and symposiums are being held to give the judges sufficient information about genetics. The Einstein Institute for Science, Health and the Courts (EINSHAC) has initiated a series of conferences, the first was held in May 1997. Conferences were held in Chicago, Salt Lake city, Orlando and Cape Code throughout 1998.[64]

A combination of laboratory, science background and judicial applications problems were the main focus of eleven molecular science conferences. The curriculum of the three days conferences of EINSHAC included genetics, molecular biology and biotechnology. Around 1,100 judges attended the conference. In 2000 and 2001 six more conferences were held catering to 1,000 judges training to keep them abreast of the latest development of genetic science.[65]

Genetic science has created wide opportunity for the lawyers of common law countries. In common law legal systems, lawyers of both sides put forward all the possible arguments on behalf of their clients. They try to

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60. *Ibid.*

61. Justice, Supreme Court of Canada.

62. Quoted in *supra* note 56, pp. 10, 11. See Gless, Some Post-Daubert Trial Tribulations of a Simple Country Judge: Behavirol Science Evidence in Trial Courts, 13 Behavirol Sci. & L., 1995, pp. 261, 263.

63. *Ibid*, p. 73.

64. Brock, The Human Genome Project and Human Identity, 29 Hou. L. Rev. 7, 16, 1992.

65. *Supra* note 56, p. 11.

maximise the full advantage of adversary system, particularly in criminal cases genetic argument is more likely to provide mitigating reasons. The more they are informed of the development of genetic science, the more strongly they can defend their clients, and the more likely they will win the case.

Lawyers of developed countries like USA, UK, and Canada seem to be aware of the recent development of genetics. Among them an increased tendency to invoke scientific findings is evidenced. They seem to have taken the new challenge. But lawyers of developing countries like Bangladesh are far behind to take the challenge. Even the judges and people associated with the justice system have no idea about the ongoing development of genetics and the challenges it posed before the lawyers and judges. They need to develop scientific expertise to cope with the changing needs.

8. DNA Test and Identification of Criminals

More than 100 countries are now using DNA technology for fast, accurate and reliable investigation of criminal cases. Particularly in murder, rape, paternity determination and immigration dispute cases, DNA technology is extensively used. Suspected criminals can successfully be identified by an analysis of DNA sample, collected from the crime scene. Deoxyribonucleic acid (DNA) is found in the nucleus of human cell. DNA sample can be collected from evidences lay in the crime scene, such as saliva, hair, blood, semen, sweat, hat, collar of shirt, handle of spectacles, hockey-stick, toothpick, stamp, envelope, bottle, can, used condom, pillow, blanket, and bed-sheet.[66]

DNA technology was first used in UK in 1987. Alec Jeffreys, a British scientist, discovered the technology. In every human body, 99% of total DNA is similar, only 1 percent is different. At intrionic region of genome this 1 percent non-functional DNA is found in abundance. DNA analysis is done by Micro Satellite Sequence (MSS). DNA consists of four types of bases, variation of which helps in identifying the individual difference. Sample registered in a police case is analysed in the laboratory. Report of DNA analysis is provided to police, judges, and lawyers., who can use it for detecting the delinquents. DNA sample is collected in presence of Magistrate and Medical Officer. Sample is carried to a laboratory in a temper-evident bag so that none can open it. The laboratory works in three phases. First, the sample is screened to ensure presence of DNA. If the screening of DNA found positive, DNA would be extracted in the second phase. In the final stage, extracted DNA is analysed and report is prepared. DNA samples are preserved in the archive, so hardly there is any scope to manipulate it, which could be re-checked if any one challenges. It is possible to give DNA-analysis report within 24 hours, but usually 7 days time is taken, which is international standard. "DNA

66. "DNA Test Ready in Bangladesh for Probe into Criminal Cases", UNB report published in *the Bangladesh Observer*, June, 26, 2005.

sample from a crime scene can be degraded due to moisture and other reasons, but in modern technology it is possible to generate DNA profile. Extracted DNA of a crime scene is amplified through polymerized chain reaction to increase the quantity as DNA content."[67] Police, judges and lawyers are given training on how to utilize DNA profile to enable them to investigate criminal proceedings.

In Bangladesh National Forensic DNA Profiling Laboratory was set up at the forensic department of Dhaka Medical College Hospital in 2005. It is an independent laboratory under the Ministry of Women and Children Affairs. The technology of DNA analysis and equipment used in this laboratory are claimed to be of international standard. FBI, Interpol and other organizations of crime detection in different countries use the same technology.[68]

Conclusion

Spectacular advancement in genetics opens the super highway to understand human nature, combination of 'genotype' and 'phenotype'. Children unfailingly inherit their traits from their parents. Now the question stands—is crime such an affliction which could be transmitted from parents to children? What hope, then, will be left for crime control? When searching answer of this question a number of twin, adoption, and family studies have been presented, even experiments in laboratories and studies on chromosomal abnormality were not left. Major limitation of those studies is that nature and nurture aspect of behaviour cannot be separated. There is, moreover, nothing in those studies to draw firm conclusion that genetic component causes antisocial or criminal behaviour, rather genetic element creates higher probability to commit crime if it gets favourable environment. Which is more important behind the crime commission—gene or environment—this type of question is superfluous as there is no satisfactory technique to separate nature and nurture, rather an interaction of gene and environment makes the crime commission predictable. Some neurochemicals and chromosomal abnormality also create higher probability for delinquent behaviour.

If an individual commits crime due to genetic component which was beyond his control, the defendant's attorney may plead to the court to consider the extenuating circumstances. This aspect of genetics requires the rectification of existing principle of criminal responsibility, putting genetically induced crime on a special category to be considered leniently. Ongoing development in genetics also underscores the necessity to correct laws relating to privacy.

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67. DR. Sharif Akhteruzzaman, National Technical Advisor of the DNA Profiling Laboratory, Bangladesh, was interviewed by UNB. See "DNA Test Ready in Bangladesh for Probe into Criminal Cases", UNB report published in *The Bangladesh Observer*, June 26, 2005.

68. *Supra* note 66.

An individual's legal responsibility is usually determined by the unitary principle with reference to the standard behaviour of a reasonable person. This principle is not applicable to children, insane and people who have behaviour disorder. A model criminal justice system keeps insane persons and children beyond the culpable responsibility, as they cannot understand the consequences of their (criminal) activities. A person requires condonation if he commits crime due to genetically transmitted traits. Legal experts, therefore, suggest that the unitary standard of reasonable person need to be modified and replaced by a more satisfactory principle.

Constitutions of most of the countries have protected citizens' right to privacy. But constitutions and laws safeguard only the external aspect of right to privacy. They did not foresee its internal (or biological) aspect, which has been uncovered by the recent genetic development. For example, Article 43 of Bangladesh Constitution protects every citizen's right to be secured in his home against entry, search and seizure; and to the privacy of his correspondence and other means of communication. It, like most of the constitutions and laws, does not protect genetic privacy of individuals, because genetic information was not available when those laws were made.

New scientific discoveries have posed a serious threat to the privacy of genetic information. Violation of genetic privacy takes place if genetic information is publicly available. Government, employer, educational institution, or any other authority may ask the students, prospective employees, and individuals to deposit their genetic information. To avoid any possible deviance they may intend to be in safe side. Authority's view may collide with the interest of the people, who seem to be reluctant to deposit their genetic information, apprehending violation of their genetic privacy, and also their submission to public ridicule. Appropriate laws are, therefore, required to give legal protection to right to genetic privacy. Some countries, most are developed, either have already enacted new laws or amended constitutions or consider to make new laws to guarantee genetic privacy of citizens. But developing and poor countries are not sufficiently prepared to take the challenges ensuing from the gentic development.

Ongoing development in genetics has legal, ethical and social implications. Societal people should be prepared to square with the new development. They also need to be wary about the possible danger as genetic information is misused and manipulated. Countries will require collective and individual efforts to minimize the misuse and utilize the genetic information to the best advantage of their citizens. Very soon the genetic revolution will pervade into every sphere of human life and revolutionize the whole human society, which will leave no corner untouched. Judiciary people will be the foremost actors to be trained sufficiently and to dispose of cases involving genetic determination in a way to prevent miscarriage of justice. Human Genome Project visualizes a radical change in human society, suggesting to develop sufficient tools to handle the aftermath of the revolution, a challenge human has ever met.