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Human Genes, Traits and Sports Performance – A Comparative Analyses

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Abstract – Human body operates and functions very systematically and scientifically with natural principles, constituting anatomy, physiology and metabolism. Anatomy deals with the structure of the body and the relationship of various parts of the body to each other. Physiology deals with normal functions of the body, illustrating various systems in the body which functions together, normally as a single unit. Metabolism comprises the anabolism and catabolism to provide the energy for the functioning of the body (Murgesh, 2003).

Human health is a state of complete physical, mental and social well-being. The mere absence of a disease alone cannot be considered as health. Physical health devotes the normal functioning and growth of all parts of body, and also the body as a whole. Mental health devotes self-satisfaction, self-control, and self-adjustment of an individual. Social health indicates the ability of an individual to adjust with the society and live in the society with all comforts and status (Murgesh, 2003).

It would be very interesting to analyze and to understand the concept of human genetics in general and chromosomes, genes and DNA, in particular, with special reference to performances of an individual in sports/games. Therefore, an attempt was made to analyze and correlate the role of genes of an individual in determining the sports performance.

Aim: To analyze and understand the inherent property (sports performance) of an individual (male or female) resulting in the off spring (children) to ensure and identify the high performance.

It may be concluded here that, the selection criteria for the best talented sports persons for a particular event shall be mainly based on the evaluation and determination of suitable genes in a particular individual. This can be achieved by testing of DNA (Deoxyribonucleic acid) of the persons under test for sports performance, by obtaining the saliva and subjecting for the test as per the standard methods in any standard laboratories. Further, Switch-on and Switch-off system of genes for their expression in an individual is drawing a great attention in the field of sports, for the excellent performance in an event/game, which requires further indepth studies.

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PRELUDE

Human body operates and functions very systematically and scientifically with natural principles, constituting anatomy, physiology and metabolism. Anatomy deals with the structure of the body and the relationship of various parts of the body to each other. Physiology deals with normal functions of the body, illustrating various systems in the body which functions together, normally as a single unit. Metabolism comprises the anabolism and catabolism to provide the energy for the functioning of the body (Murgesh, 2003).

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All activities of the human body are the results of highly coordinated actions and reactions or functions of all the components of the body. The factors which determine and regulates with the activities of the

body according to the degree or requirement of all individual are so called human genes. The system in which all the genes operates put together is normally known as human genetics. The central dogma of human genetics is the DNA (Brachel and Mirsky, 1961 and Hartwell, 1978).

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Aim: To analyze and understand the inherent property (sports performance) of an individual (male or female) resulting in the off spring (children) to ensure and identify the high performance.

HYPOTHESIS

- The inherent property (sports performance) is highly determined and regulated by the genes.
- Every inherent property (sports performance) of an individual may or may not express in the off springs.
- The expression of inherent property (sports performance) is under the influence of prevailing health and environment conditions.
- The expression of inherent properties (sports performance) can be induced and modulated in an individual.

HUMAN GENOME

A single unit of human body is a cell. These cells in different permutations and combinations forms tissues, muscles, organs, bones, etc., all of which are essential to perform the general activities of the body. The total genetic control of a cell constitutes its genome. The entire genome or genetic material exists as a chromosome in which genes are arranged linearly containing DNA. This DNA is the hereditary material which carries genetic information in a coded fashion. Though, DNA is a complex molecules, it exhibits enormous consistency and regulatory in a reproduction. The hereditary traits/qualities are controlled by genes which are located in the human chromosomes.

Wherever a cell divides DNA – the blue print carrying a set of a instructions is duplicated exactly, and handed onto the daughter cell without any modification. In order to understand this mechanism a chromosome theory of heredity was prepared by Sultan in 1902, which stated that, hereditary factors or genes are located on chromosomes and transmitted from parents to offspring's according to the certain laws. The relationship between chromosomes and genes was well narrated and one of the important observation is that, each chromosome has a definite role in the life and development of an individual (Albert's Brule et al., 2002).

Today, we understand that a gene is a stretch of one stretch of a DNA molecule which carries information for direction of the synthesis of specific protein targeting a particular activity/function. After, having established the physical and chemical nature of genes, the functional aspect of the gene was realized with a relationship between genes and enzyme. This concept was established as one gene – one enzyme hypothesis and later it was modified as one gene – one polypeptide hypothesis.

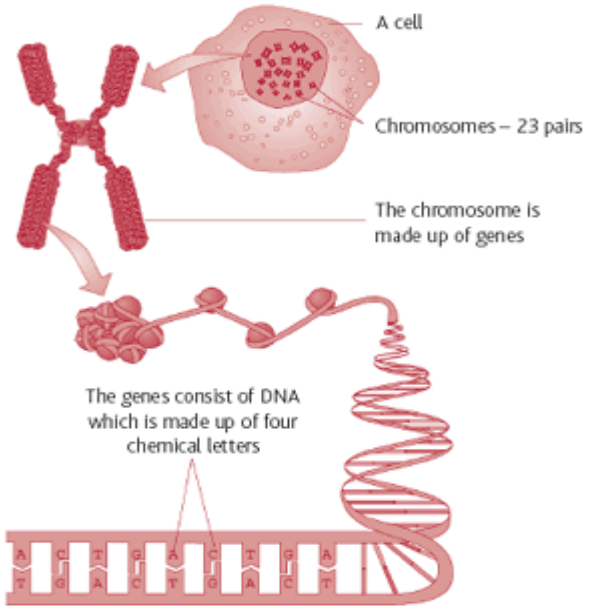
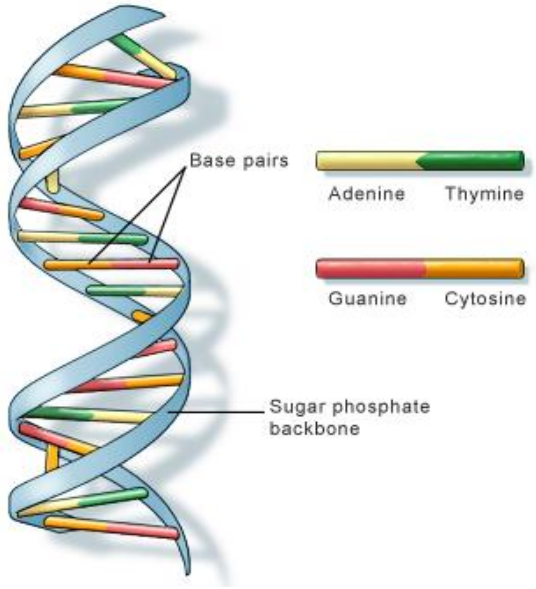


Diagram illustrating a cell, chromosome, location of genes and DNA content

The chromosomes have a linear arrangement of genes, which represent specific length of DNA. Each gene (Specific length on one strand of the helix) is divided into coding and non-coding regions. The coding region carries a nucleotide sequence with hereditary information flanked on other side by non-coding regions (Lewin, 1980).

We shall now explore the molecular nature of the genetic material and its functional components, because only in the molecular structure of the gene lies the explanation of its actual working genes, which are component of the DNA, which determine the characteristics of individuals and it is thought that, these characteristic are handed down to the off spring. Therefore, it follows that, genes must contain the information that guides an individual to develop along with certain traits. It is also comparative that, the genetic materials of which gene are the constituents, must be able to replicate or reproduce

without losing any of its information contents (Crick, 1974; Daries and Zimmerman, 1980; Watson and Crick, 1953).

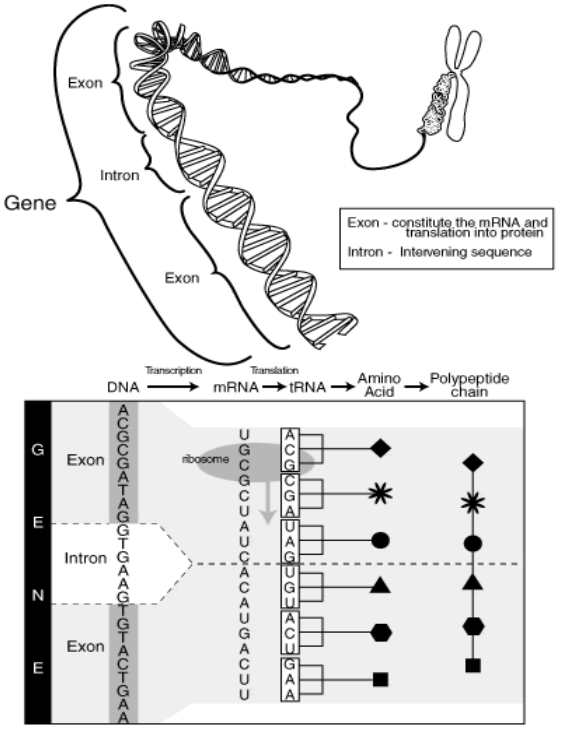


Structure of DNA showing four base pairs

Nucleic acids are the informational molecules where the genetic information is encoded in the four – letter alphabet (A, T, G and C) and gets translated into proteins through a precise and complicated mechanism. Amino acids are the alphabets of proteins which are assembled into meaningful sequence dictated by the nucleotide sequence on the nucleic acids. The synthesis of peptide bonds is the principal chemical event in protein synthesis which is coupled to sophisticated machinery for the precise translation of specific nucleotide sequences of primary interest is the mechanism by which information from DNA is used in a specific manner for the synthesis of protein.

HUMAN GENES

It is essential to understand human genes in relation to performance of different sports and games reported by several other researchers.



Expression of genes for a specific polypeptide/protein

METHODOLOGY

The important protocol to be followed for the genotyping of a sports individual as prescribed by Ryan et al. (2010), in brief is as follows.

- Saliva sample of test individuals be collected for genotyping using DNA self-collecting kits.
- The saliva be stored at room temperature.
- DNA be extracted according to standard methodology.
- Genotyping be performed using pre-mode Taq-Man single nucleotide polymorphism genotyping assay and recorded using real time PCR instrument.
- Central DNA samples with known genotypes be used for assay validation.
- Analyses of DNA sequence variation be performed using statistical analyses software genetic package (Murgesh, 2003).

REPORTED SPORTS GENES

1. ALPHA ACTININ (ACTN 3)

It was reported by Kathrine North, when he was studying people with neuro-muscular disorders in the hope of finding a cause, if not a care. It was reveal that; it controls the production of a specific protein in muscles. This gene produces alpha actinin – 3, found in fast twitch muscles, the types that are predominately used to make power requirements such as sprint and jump (Will, 2001; Ronald, 2006).

Individual exhibiting a power of Sprint and Jump respectively

Everyone have the two copies of the ACTN 3 gene, with one copy inherited from each parent. In any one gene there may be subtle variations. Scientists have found a variant, known as R577X, in the ACTN3 gene, that alter the way the body reads the ACTN3 gene instruction. As everyone has two copies of the ACTN3 gene, there are three different combinations or sports performance types.

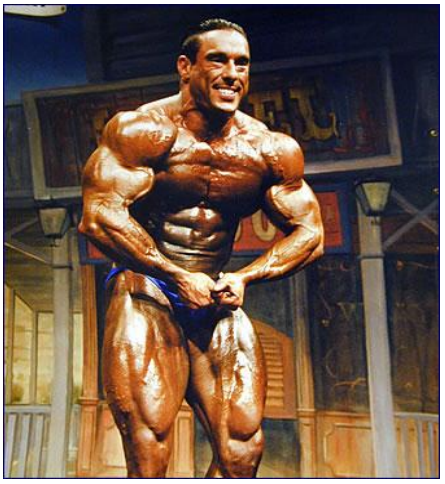
XX Type: You have the R577X variant present in both copies of your ACTN3 gene – studies of the elite athletes from the Australian institute of sports (AIS) show, that this combination is associated with a natural predisposition to endurance event.

RR – Type : You do not have the R577 X variant present in either copy of your ACTN3 gene. The absence of the R577X variant from both copies of the ACTN3 gene is associated with a natural predisposition for sprint power events.

RX – Type : You have the R577X variant present in one of the two copies of your ACTN3 gene. If you have this combination you may equally suited for both endurance and sprint power events.

2. Myostatin

Myostatin is a gene that contributes to the differentiation in growth factors, including physical size, and regulates muscles development. Unlike these factors that spur the growth of human structures, myostatin prevent muscles from growing too large. It is protein produced in the skeletal muscle cells, interacting with the production of myocytes, the cell that ultimately from muscles (Montgomery et al., 1998).



Individual exhibiting power of muscles

Muscle size is both an inheritable trait as well as an attribute that may be altered through physical training, coupled with diet. A large number of proteins, referred to as growth factors (GFs) operate in different ways with in the body. A growth factor will generally signal a cell as to its rate of growth and any differentiation from other cells.

A muscle size is inheritable, there exists the potential to create a variable gene, where the increase in muscles size in an athlete could be achieved through a decrease in the action of myostatin.

3. Apolipoprotein E

Apo lipoprotein E (APOE) is a plasma lipoprotein which plays a role in nervous tissue healing. It aids in neuron – protection and the repair via., the transportation of lipids as demonstrated by its up regulation after seasonal stress. Apo lipoprotein E gene variations (Polymorphism) occur in the promoter

and coding regions which effect APOE expression and quality and quantity respectively. The altered natural environment created by APEO polymorphism may influence the ability of neuron to function and recover properly from mechanical stress and therefore particularly hazardous if carried by athletes with a high number of head impacts. There has been a paucity of research examining the association between sports related concussion occurrence and APOE genotype (Hootman et al., 2007; Kristman et al., 2008; Terrell et al., 2008; Kutner et al., 2000).

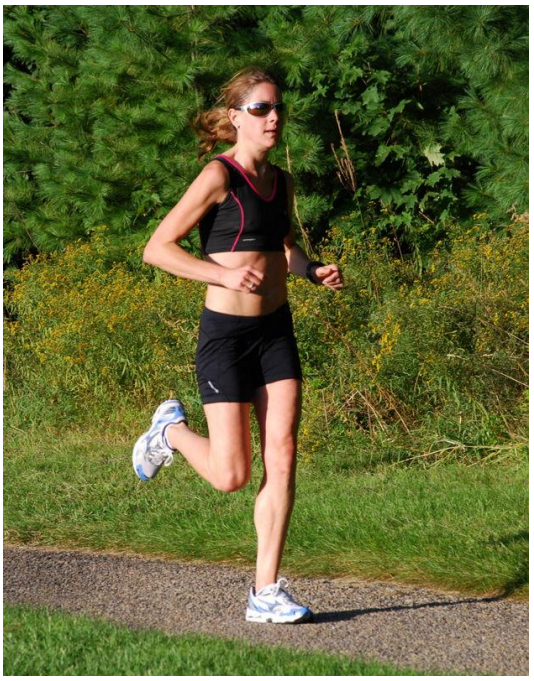
(a)

(b)

Athlete recurring from an injury (a) Injured athlete (b) Recovered athlete

4. Erythropoietin

Erythropoietin is a hormone regulates the number of red blood cells. When such gene is altered the EPO receptor enables blood cells to carry higher level of oxygen, similar to blood doping. It helps in increase of cardiovascular stamina.



Endurance of an athlete for long distance running

A variant of the body kinetin beta 2 receptor genes (BUKBR2) has recently been linked to the ability to run long distance in Olympic standard athletes.

ANALYSIS

Whether sports individuals are born or made. In light of the reported genes, yes, it is true that sports individuals are born with certain specific genes but need to be made also for high performance. It has been said that when gene talks sports walk and genes and sports are like heart and beat.

Single gene expresses a single character of a particular sports trait. Genetically a single gene express single protein which infact causes activation for a specific sports activity. There are some specific gene which works together in group in a sporty body. Presences and expression of specific genes in a body favour the body to develop into a sporty body. However, expression of genes, sometime under goes switch on – switch off mechanism in prevailing conditions (Fox et al., 1996; Gayagay et al., 1998).

More than training to make a sportive body for high performance, the body be bestowed with sports genes. Therefore, it is necessary that, talent identification for higher sports performance, geno-typing of an individual is supposed to be mandatory. Thus, geno-typing of perspective sports persons will become an option, when performance or injury genes

have been identified, but many will regard the practice as unethical.

SUMMARY

Genes are the fundamental units of inheritance and are the structural and functional units of sequence of DNA in the genome that is required for production of a functional production. Genes have both minor and major effects on human characteristics. Human genes have become prominent in the nature versus nurture debate. About 20,000 to 25,000 protein coding genes have been identified in human DNA and these genes are distributed unevenly across the chromosomes. Each chromosome contains various gene-rich and gene-poor regions.

In addition to protein coding genes, the human genome contains several thousands of other genes.

Several genes have been well identified and characterized to indicate a high physical performance in the body of an individual in general and a sports person in particular. Genes responsible for the successful achievements of athletes, wrestlers, footballers and others have been reported by several experts in the field. Speed, strength, endurance, stamina, flexibility and agility are some of the vital characteristic features of a successful sports personality or these are basic traits of a sports individual for high performance. The recent advances made in the human genome project and understanding of several human genes with regard to their functional features, it has become possible to correlate and analyze the role of human genes in the high performance of a sports person.

CONCLUSIONS

- Genotyping of all individuals for constant and stable high performance in the sports is essential.
- Identification of particular genes and traits of an individual to achieve the excellence in a particular event must be carried out.
- Maintenance of the genomic stability over a long period of time is quite possible.
- The expression of inherent property (sports performance) is highly variable depending upon the prevailing physiological and environmental conditions.

The important and consolidated features of this paper are as follows:

1. The talent and performance of a sports person is mainly indigenous inbuilt, without which a talent or performance cannot be consistent and long lasting.
2. Indigenous and in built capacity of a sports person is determine and regulated by some specific genes in terms of specific qualities or traits, such as power, speed, endurance, etc.
3. Evaluation of specific genes and their functions in a sports individual shall be a basic criteria for the selection of sports person for a suitable event, depending upon the types of genes being carried out by the individual.

Illustrations - 1: A highly consistent and supreme performance of Sachin Tendulkar in cricket shall be attributed to all the specific genes suitable for the required physical trait/quality. Why? It is not being observed in other cricketers. The most probable reason for this may be that either those specific genes are not expressive or required to be induce/trained. This is the reason why extreme good performance is some time being observed in some cricketers, occasionally.

Illustration - 2: The performance or talent of a sports person for a particular event can be selected and adjudged based on the type of suitable functional and expressive genes. It has been already reputed and established that, there are few specific genes for a suitable trail or quality required for that particular event, which are as mentioned under:

Alpha Actinin (ACTN 3), Speed and Jump (Athletic – Hassuan Bolt and Basket Ball)

Myostatin – It is for the muscle strength (Khalli)

Apolipoprotein E – Healing - athletic events (Injure and Recovery)

Erythropoietin – Endurance (long distance running)

CONCLUSION:

It may be concluded here that, the selection criteria for the best talented sports persons for a particular event shall be mainly based on the evaluation and determination of suitable genes in a particular individual. This can be achieved by testing of DNA (Deoxyribonucleic acid) of the persons under test for sports performance, by obtaining the saliva and subjecting for the test as per the standard methods in any standard laboratories. Further, Switch-on and Switch-off system of genes for their expression in an individual is drawing a great attention in the field of sports, for the excellent performance in an event/game, which requires further indepth studies.

REFERENCES

Albert's Brule, et al. (2002). Molecular biology at the cell 3d ed., New York: Garland.

Brachel, J. and A. E. Mirsky (eds.). (1961). The Cell, Vol. 3, Academic Press, New York.

Crick, F. H. C. (1974). "The Double Helix a personal view", Nature, 248: p. 766.

Daries, D. R. and S. Zimmerman (1980). "A New Twist for DNA", Nature, 283: p. 11.

Fox, P. W., Hershberger, S. L., Bouchard, T. J., (1996). Genetic and environmental contributions to the acquisition of a motor skill, Nature, 384: pp. 356-358.

Gayagay, Yu B., Hambly B. Boston, T., Hahn A., et al., (1998). Elite endurance athletes and the ACE/Allele – the role of genes in athletic performance. Human Genetics, 103, pp. 48-50.

Hartwell, L. H., (1978). "Cell Division from a genetic prospective". J. Cell Biol., 77: 627.

Hootman, J. M., Dick, R., Agel, J. (2007). Epidemiology of collegiate injuries for 15 sports: Summary and recommendations for injury prevention initiatives. J. Athl. Train, 42: pp. 311-319.

Kristman, V. L., Tator, C. H., Kreiger, N. et al., (2008). Doest the Apo lipoprotein E4 allele predispose varsity athletes to concussion? A prospective cohort study. Clin. J. Sport. Med., 18: pp. 322-328.

Kutner, K. C., Erlanger, D. M., Tsai, J. et al., (2000). Lower cognitive performance of old football players possessing apolipoprotein. E. Epsilon, A. Neurosurgery, 47: pp. 651-69.

Lewin, B., 1980. Gene expression, 2: Eukaryotic Chromosome, 2nd Ed., John Wiley, N. Y.

Montgomery, H. E., Marshall, R., Hemingway, H., Myerson, S., Clarkson, P., et al. (1998). Human gene of physical performance. Nature, 393: pp. 221-222.

Murgesh, N. (2003). Anatomy physiology and health education, Sathya Publishers, Tirunagar Madurai, India.

Ronald, J. A. Trent (2006). Sports Science 5 (1). University of Sydney, NSW, Australia.

Terrell, T. R.., Bostick, R. M., Abramson, R. et al. (2008). APOE, APOE, promoter and tan genotypes and risk for concussion in college athletes. Clin. J. Sports Med., 18: pp. 10-17.

Watson, J. D. and F. H. C. Crick, (1953). "Molecular structure of nucleic acid. A Structure for deoxyribose Nucleic acid". Nature, 171: p. 737.

Will, G. Hopkins, 2001. Genes and Training for Athletic Performance.

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