



Genetic Testing in Sports

Prelims: Genetic Testing, Methods, Genetic Information and Privacy, DNA Test.

Mains: Genetic Testing Needs, Concerns, Advantages, Disadvantages, Research and Development.

[Source: DTE](#)

Why in News?

The emergence of genetic testing in sports has gained significant attention, especially with athletes utilising it for performance enhancement ahead of the **2024 Paris Olympics**.

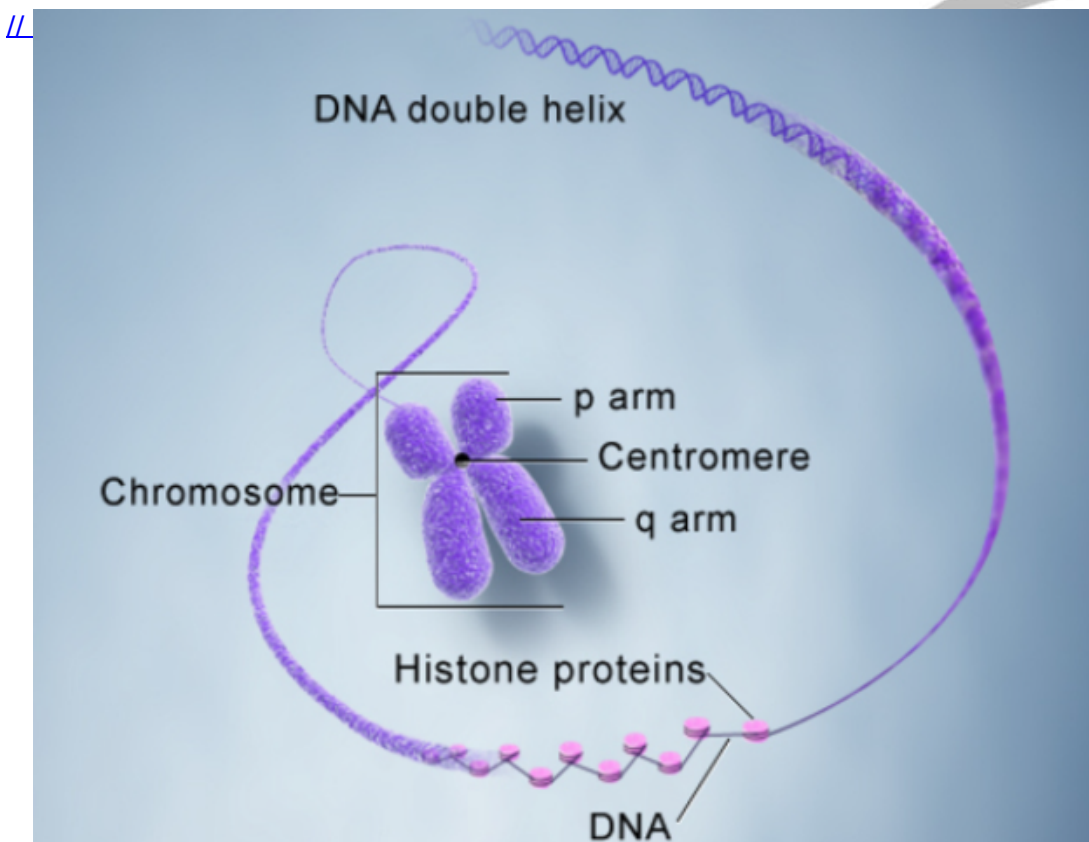
- This trend has sparked debates about the potential benefits and ethical concerns surrounding athletic genetic screening.

What is Genetic Testing?

- **About:**
 - **Genetic testing** involves analysing an individual's DNA to identify genetic variants that can influence health, traits, and performance.
 - It detects **alterations in chromosomes, genes, or proteins** to confirm or exclude genetic conditions and assess the likelihood of developing or transmitting genetic disorders.
 - These tests can be conducted **using samples from blood, hair, skin**, amniotic fluid, or other tissues.
- **Types:**
 - **Cytogenetic Testing:** Examines whole chromosomes.
 - **Biochemical Testing:** Measures proteins produced by genes.
 - **Molecular Testing:** It detects small DNA mutations.
- **Applications:**
 - **Newborn Screening and Diagnostic Testing:** Genetic testing can be conducted just **after birth to identify treatable genetic disorders**. It can be used to confirm or rule out specific genetic conditions based on physical signs and symptoms.
 - **Carrier Testing:** It identifies individuals **carrying one copy of a gene mutation that could cause a genetic disorder if present** in two copies. Useful for those with a family history of genetic disorders or belonging to certain high-risk ethnic groups.
 - **Preimplantation Testing (PGD):** It can be used in conjunction **with in-vitro fertilisation to test embryos for genetic changes** before implantation, reducing the risk of genetic disorders.
 - **Forensic Testing:** It utilises DNA sequences for legal purposes, such as identifying **crime victims, suspects, or establishing biological relationships**.

What are Genes, DNA and Chromosomes?

- **DNA:**
 - DNA is a long molecule that contains our **unique genetic code**. DNA is composed of 2 strands that wrap around each other to form a **double helix shape**, like a spiral staircase.
 - Each strand of DNA is formed of 4 basic building blocks or 'bases': **adenine (A), cytosine (C), guanine (G), and thymine (T)**.
- **Gene:**
 - Genes are **sections of DNA** that contain the **set of instructions** to produce one specific molecule in the body, usually a protein.
 - These proteins control how the body grows and works and are responsible for characteristics like eye colour, blood type, or height.
 - **Each cell contains 2 sets of genes**, one from your mother and one from your father. For ease of storage and access, the **genes are packaged up into 46 parcels called chromosomes**.
- **Chromosome:**
 - In the nucleus of each cell, the DNA molecule is packaged into **thread-like structures** called chromosomes.
 - Each chromosome is made up of DNA tightly coiled many times around proteins called histones that support its structure.
 - **Chromosomes are not visible in the cell's nucleus**, even under a microscope.



How is Genetic Testing Used to Improve Athlete's Performance?

- **Identification of Genetic Markers:** Genetic testing can reveal specific markers associated with physical traits that contribute to athletic performance.
 - For example, variations in genes like **ACE (angiotensin-converting enzyme)** and **ACTN3 (alpha-actinin 3)** have been linked to **endurance** and **strength capabilities**, respectively.
- **Assessment of Muscle Fiber Composition:** The **ACTN3** genes influence the proportion of fast-twitch muscle fibres, which are crucial for explosive strength and sprinting.

- Athletes with certain variants of this gene may be predisposed to excel in power sports, while others may have a genetic makeup favouring endurance activities.
- **Evaluation of Recovery and Injury Risk:** Genetic testing can identify predispositions to injuries or recovery times.
 - For instance, **variations in genes related to collagen production** can indicate **susceptibility to tendon and ligament injuries**, allowing for tailored training and preventive strategies.
- **Nutritional Needs and Metabolism:** Genetic insights can help determine how well an athlete metabolises nutrients.
 - For example, identifying **lactose intolerance or variations in vitamin D metabolism** can guide dietary choices that optimise performance and overall health.
- **Psychological Traits:** Certain genetic variants may influence psychological traits such as motivation, stress response, and pain tolerance, which are critical for competitive success.
 - Understanding these traits can help in mental conditioning and preparation.
- **Tailored Training Programs:** By understanding an athlete's genetic predispositions, **coaches can design training regimens** that align with their strengths and weaknesses, enhancing performance potential.

What are the Limitations of Genetic Testing?

- **Scientific Uncertainty:** The relationship between genetics and athletic performance is **complex and not fully understood**.
 - Many studies yield conflicting results, making it difficult to draw definitive conclusions.
- **Small Sample Sizes:** Many genetic studies involve limited sample sizes, which can affect the reliability and generalisability of findings across different populations and sports.
- **Overemphasis on Genetics:** Focusing too much on genetic factors **can overshadow the importance of training, practice, nutrition**, and psychological aspects, which are crucial for athletic success.
- **Ethical Concerns:** Issues related to **privacy, potential discrimination**, and misuse of genetic information **pose significant ethical challenges for athletes**.
- **Misinterpretation of Data:** Genetic data can be **complex and may be misinterpreted without expert guidance**, leading to incorrect conclusions about an athlete's potential.
- **Commercial Exploitation:** The rise of direct-to-consumer **genetic testing often prioritises profit over scientific validity**, raising concerns about the accuracy of results and the motivations behind testing.

Way Forward

- **Independent Research:** Encourage comprehensive studies by independent scientific bodies to **validate findings on genetic influences** and understand gene interactions better.
- **Education and Training:** Provide training for coaches and nutritionists to accurately **interpret genetic data and apply it effectively** in athlete development.
- **Ethical Guidelines:** Develop clear ethical guidelines to **protect athletes' privacy and prevent discrimination based on genetic information**, ensuring responsible use of data.
- **Holistic Approach:** Emphasise a balanced approach that integrates genetic insights with traditional training, nutrition, and psychological support, recognising the interplay of genetics and environment.
- **Collaboration with Regulatory Bodies:** Work with sports organisations to create policies **governing the use of genetic testing**, ensuring fairness and standardisation in practices.
- **Public Awareness Campaigns:** Conduct campaigns to educate athletes and the public about the **benefits and limitations of genetic testing**, promoting informed decision-making.

Conclusion

While genetic testing can provide valuable insights into athletic potential, it is crucial to combine these findings with environmental factors, training, and personal dedication to fully realize an athlete's capabilities.

UPSC Civil Services Examination, Previous Year Questions (PYQs)

Q. What is Cas9 protein that is often mentioned in the news? (2019)

- (a) A molecular scissors used in targeted gene editing
- (b) A biosensor used in the accurate detection of pathogens in patients
- (c) A gene that makes plants pest-resistant
- (d) A herbicidal substance synthesized in genetically modified crops

Ans: (a)

Q. With reference to agriculture in India, how can the technique of 'genome sequencing', often seen in the news, be used in the immediate future? (2017)

1. Genome sequencing can be used to identify genetic markers for disease resistance and drought tolerance in various crop plants.
2. This technique helps in reducing the time required to develop new varieties of crop plants.
3. It can be used to decipher the host-pathogen relationships in crops.

Select the correct answer using the code given below:

- (a) 1 only
- (b) 2 and 3 only
- (c) 1 and 3 only,
- (d) 1, 2 and 3

Ans: (d)

Mains

Q. What are the research and developmental achievements in applied biotechnology? How will these achievements help to uplift the poorer sections of society? (2021)