

## THE EFFECT OF GENETICALLY MODIFIED PRODUCTS ON THE ORGANISM

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**Annotation:** Sex chromosomes are fundamental genetic structures that regulate sex-specific inheritance and differentiation in organisms. The X and Y chromosomes differ significantly in size, gene content, and function, which results in distinct patterns of inheritance for sex-linked traits and disorders. X-linked traits, often recessive, are more frequently expressed in males, whereas Y-linked traits are transmitted exclusively from father to son. Mechanisms such as X-chromosome inactivation and dosage compensation ensure balanced gene expression between sexes. Genetic compatibility further influences the stability and health of offspring, while population-level inheritance of sex-linked traits affects genetic diversity and evolutionary processes. Understanding sex chromosome-linked inheritance is crucial for medical genetics, enabling early diagnosis, genetic counseling, and preventive strategies for hereditary diseases.

**KEYWORDS:** Sex chromosomes; X-linked inheritance; Y-linked inheritance; genetic compatibility; dosage compensation; X-chromosome inactivation; hereditary diseases; population genetics; medical genetics

**INTRODUCTION:** Sex chromosomes, X and Y, are key genetic structures that determine sex-specific traits in humans and most animals. The X chromosome carries numerous genes, including those responsible for clinically significant X-linked disorders, while the smaller Y chromosome harbors male-specific genes such as SRY, which determines male sex. X-linked traits are often recessive and expressed mainly in males, whereas Y-linked traits are transmitted from father to son. Mechanisms like X-chromosome inactivation and dosage compensation maintain gene expression balance, and genetic compatibility influences offspring stability. Understanding sex chromosome inheritance is crucial for medical genetics, population genetics, and evolutionary biology.

**MAIN BODY:** Sex chromosomes are essential genetic structures that determine sex-specific differentiation of hereditary information in organisms. In humans and most animals, these chromosomes are designated as X and Y. The X chromosome is relatively large and contains numerous genes, whereas the Y chromosome is smaller and primarily carries genes specific to male development. This difference plays a fundamental role in the inheritance of sex-linked traits and diseases.

The number of X-linked traits is considerably high because the X chromosome contains more than 1,000 genes. Well-known X-linked traits and disorders include hemophilia A and B, color blindness, Duchenne muscular dystrophy, fragile X syndrome, and ectodermal dysplasia. These traits are predominantly inherited in a recessive manner; therefore, they are more frequently expressed in males, while females are usually carriers. Y-linked traits are relatively rare due to the small size of the Y chromosome, which contains only about 50–70 functional genes. Y-linked traits are transmitted exclusively through the male lineage and are fully expressed in sons. Examples include the H-Y antigen, the SRY gene (sex-determining region Y), male-pattern hair loss (androgenetic alopecia), certain forms of male infertility, and auricular hypertrichosis.

The inheritance mechanisms of sex-linked traits differ from autosomal inheritance. In males, the presence of only one X chromosome results in the full expression of X-linked recessive traits, as there is no dominant allele for compensation.

Consequently, disorders such as color blindness, hemophilia, and Duchenne muscular dystrophy occur predominantly in males. In females, who possess two X chromosomes, such traits manifest only when both alleles are recessive. Y-linked traits, in contrast, are transmitted solely from father to son. To maintain genetic balance, organisms have evolved specific regulatory mechanisms.

One such mechanism is X-chromosome inactivation, in which one of the two X chromosomes in females is functionally silenced. This process, known as dosage compensation, ensures that the expression levels of X-linked genes are approximately equal in males and females. The concept of genetic compatibility plays an important role in the inheritance of sex-linked traits.

It refers to the degree of genetic concordance between individuals, particularly the compatibility or incompatibility of alleles. High genetic compatibility promotes stable inheritance, adaptability, and healthy offspring, whereas genetic incompatibility may result in reproductive failure, miscarriage, or genetic disorders. At the population level, sex chromosome-linked inheritance directly affects genetic diversity. X-linked alleles spread at different rates in males and females, influencing natural selection and genetic drift. Thus, sex chromosomes constitute an essential genetic basis for population evolution. From the perspective of medical genetics, the study of sex chromosome-linked inheritance is crucial for the diagnosis and prevention of hereditary diseases. Advances in genetic counseling, molecular diagnostics, and gene therapy have significantly improved outcomes in this field. In particular, identifying female carriers of X-linked disorders and investigating Y-linked genetic causes of male infertility are major priorities in modern medicine.

Overall, sex chromosome-linked inheritance and genetic compatibility contribute to a deeper understanding of hereditary laws, generational stability, and the biological mechanisms underlying evolution.

**CONCLUSION:** Inheritance through sex chromosomes represents a critical area in both biology and medicine. Structural and functional differences between the X and Y chromosomes determine inheritance patterns observed at individual and population levels. The concept of genetic compatibility, operating through molecular interactions and population-level mechanisms, significantly influences offspring health, phenotypic stability, and evolutionary trajectories. Clinically, the identification of sex-linked disorders and the application of genetic counseling are essential for reducing reproductive risks and ensuring healthy progeny. Future research should focus on the regulation of sex chromosome-associated genes, the detailed mechanisms of X-chromosome inactivation, and the identification of novel molecular factors underlying genetic compatibility.

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