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Blood Types and Beyond: Co-dominance in Inherited Haematological Disorders

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Abstract

Co-dominance is a genetic phenomenon where both alleles of a gene are expressed simultaneously in the phenotype of a heterozygous individual. Unlike traditional Mendelian inheritance, where one allele dominates the other, co-dominance results in a blending or co-expression of traits. This phenomenon is particularly evident in blood type inheritance, where the ABO system showcases co-dominance between the A and B alleles, leading to distinct blood types. In co-dominant traits, the heterozygous individual exhibits a phenotype that is a unique combination of both alleles, rather than a simple intermediate. This complex interplay between alleles adds a layer of diversity and complexity to genetic inheritance patterns, contributing to the rich tapestry of biological diversity.

Keywords: Blood group • Phenotypes • Haematological disorders

Introduction

The study of blood types has long been a fundamental aspect of human genetics, providing insights into inherited traits and susceptibility to certain diseases. Beyond the ABO and Rh blood group systems, the field of inherited haematological disorders delves into the intricate genetic mechanisms that govern blood-related conditions. One fascinating aspect of these disorders is the phenomenon of co-dominance, where two different alleles contribute equally to the phenotype, resulting in a unique pattern of inheritance. In this exploration, we will delve into the world of co-dominance within the realm of inherited haematological disorders, unravelling the complexities that govern blood-related traits and conditions. To comprehend the concept of co-dominance in inherited haematological disorders, a foundational understanding of blood types is crucial. The ABO blood group system, consisting of four main blood types – A, B, AB and O – is determined by the presence or absence of antigens and antibodies on the surface of red blood cells. Additionally, the Rh factor adds another layer of complexity, categorizing individuals as Rh-positive or Rh-negative. These basic blood types lay the groundwork for exploring more intricate genetic patterns in haematological disorders [1].

Literature Review

In classical Mendelian genetics, an individual inherits one allele from each parent, and the dominant allele typically masks the expression of the recessive allele. However, co-dominance introduces a unique scenario where both alleles are expressed simultaneously, resulting in a phenotype that displays traits of both alleles. This phenomenon is particularly evident in certain blood group systems, such as the MN blood group and the Duffy blood group, where co-dominant alleles contribute to the final blood type of an individual. The MN blood group system is a classic example of co-dominance in blood type inheritance. The system is determined by two co-dominant alleles, M and N. Individuals can be homozygous MM or NN, expressing only one allele, or heterozygous MN, expressing both alleles simultaneously. The resulting phenotypes are distinguishable, with MM individuals having an M blood type, NN individuals having an N blood type, and MN individuals exhibiting a mixed MN blood type. Understanding the co-dominant nature of the MN blood group system provides a glimpse into the intricacies of blood type inheritance beyond the more straightforward ABO system [2,3].

Discussion

Another instance of co-dominance in blood type inheritance is observed in the Duffy blood group system. This system is characterized by two co-dominant alleles, Fya and Fyb. Similar to the MN blood group system, individuals can be homozygous for either allele (FyaFya or FybFyb) or heterozygous (FyaFyb). The resulting phenotypes are distinct, with FyaFya individuals having an Fya blood type, FybFyb individuals having an Fyb blood type, and FyaFyb individuals expressing both alleles with an FyaFyb mixed blood type [4].

Moving beyond blood group systems, co-dominance is also evident in inherited haematological disorders associated with haemoglobin. Sickle cell anemia, a well-known hemoglobinopathies, provides a compelling example of codominance in the context of a debilitating blood disorder. Sickle cell anemia is caused by a mutation in the HBB gene, leading to the production of abnormal hemoglobin, HbS. Heterozygous individuals with one normal allele (HbA) and one mutant allele (HbS) experience a codominant expression of both alleles, resulting in a condition known as sickle cell trait. These individuals, while not exhibiting the severe symptoms of homozygous HbS individuals with sickle cell anemia, may still manifest some characteristics of the disorder under certain conditions. This co-dominant pattern of inheritance sheds light on the variable expressivity and penetrance associated with inherited haematological disorders [5,6].

Conclusion

The exploration of blood types and inherited haematological disorders unveils the fascinating realm of co-dominance in genetic inheritance. From the MN blood group system to the Duffy blood group system and the complexities of hemoglobinopathies like sickle cell anemia, the interplay of co-dominant alleles adds layers of intricacy to our understanding of blood-related traits and conditions. As genetic research continues to advance, unravelling the mysteries of co-dominance in haematological disorders opens new avenues for targeted therapies and personalized medicine, bringing us closer to a comprehensive understanding of the genetic basis of blood-related traits and diseases.

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Conflict of Interest

There are no conflicts of interest by author.

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