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On the mode of transmission of X-chromosomes in the ancestral table (Ahnentafel)

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Although the primary interest for most genealogists engaged in family research is historical, particularly when this goes back as far as the 17th or l6th century, certain genetical aspects may also be considered. In fact, the individual ancestor does not necessarily transmit the percentage of genetic units calculable from the genealogical table to the person under investigation. For example, we would expect $1/64^{th}$ of an ancestor's genetic material from the 64th ancestral line to be passed on to the person being investigated. However, as a result of meiosis half of the individual's chromosomes are not transmitted and so it is largely a matter of chance from which ancestor the person receives a greater or smaller share of genes. As I showed some time ago, in extreme cases it is even possible that not a single gene is inherited from one of the grandparents. [1)]

Although ancestors who lived long ago are of more or less minor interest from the scientific point of view – most hereditary factors cannot be reconstructed and from which ancestor this or that gene was inherited remains an open question - Arndt Richter pointed out in a remarkable article dedicated to Prof. Rösch that there are other conditions for sex chromosomes because of their special mode of transmission. [2)]

It is known that a man's pair of sex chromosomes consists of one X- and one Y-chromosome, while a woman has two X-chromosomes. The Y-chromosome is only passed down from father to son, i.e. purely patrilineal; this has long been recognised in literature and is common knowledge among biologists and historians. Surprisingly, it had been overlooked or only marginally noticed that this mode of transmission for the Y-chromosome must mean that there is also a special mode of transmission for the X-chromosome which prevents a large number of ancestors from passing on **t h i s** chromosome with all its genes to the person being investigated. It is thanks to Arndt Richter that this was pointed out.

Briefly, a man has the Y-chromosome from his father and the X-chromosome from his mother. None of the genes present in the f ather' s X-chromosome can therefore be passed on.

A woman has two X-chromosomes, one from her father and one from her mother. She receives the X-chromosome factors of both parents. Of her grandparents her father' s father is excluded, so she can only receive X-chromosome factors from three of her four grandparents. If we further investigate the fact that a male person' s father is always eliminated from transmitting the X-chromosome factors, and ask who in the family tree could have carried the X-chromosome factors of the person being investigated, the following sequence of numbers is found :

A male can inherit the X-chromosome from the following number of persons:

of 2 parents	1 person
of 4 grandparents	2 persons
of 8 greatgrandparents	3 persons
of 16 ancestors	5 persons

A female can inherit the X-chromosome from the following number of persons:

of 2 parents	2 persons
of 4 grandparent s	3 persons
of 8 greatgrandparents	5 persons
of 16 ancestors	8 persons

The number of possible persons is the same for both sexes but with a one-generation shift. The number of possible persons from whom the X-chromosome factors can be inherited increases from generation to generation in the following sequence:

2, 3, 5, 8, 13, 21, 34, 55, 89, 144, 233

but it is always increasingly lower than the number of ancestors in each generation so that in a woman's 1024th line only 144 persons (14.06%) and in a man's 1024th line only 89 persons (8. 69%) can have transmitted X-chromosome factors to the person in question. The further back we go, the lower is the percentage of possible ancestors involved in passing on X-chromosomes in relation to the total number of ancestors. (It could be interesting to search out these persons in your own ancestral table.)

It should be stressed again: not everyone who could share X-chromosome factors with the person being investigated is necessarily involved; important is the certainty that an increasingly large number of ancestors **c a n n o t** share these factors with him.

1) Ahnentafel, Stammtafeln und Nachfahrentafeln. Leipzig 1932, II. Erbkunde, S. 11-22. (= Mitteilungen der Zentralstelle für Deutsche Personen- u. Familiengeschichte Leipzig, H. 57).
2) Arndt Richter: Erbmäßig bevorzugte Vorfahrenlinien bei zweigeschlechtigen Lebewesen. Die Spaltungsproportionen in der Aszendenz bei der geschlechtsgebundenen Vererbung, erläutert am Beispiel des Menschen.
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