Background: Hereditary diseases form an omnibus problem in Arab societies in general and in rural Arab societies in particular.

Aim: Study of hereditary blindness and its relation to endogamous marriage among the Gharaghir tribe in the Jordan valley.

Methodology: The researchers carried out a fieldwork among the Gharaghir tribe in Al-Sawalha (the northern valley region, Deir Alla, the Hashemite Kingdom of Jordan) using participant observation, and intensive focussed interviews, in addition to the genealogical method. We gathered data on endogamous marriages, blindness, genealogy and the degrees of kinship between the spouses.

Results and Discussion: The results show that blindness among the Gharaghir was found to be associated with endogamous marriage. Marriage among the established ancestors of the clans used to be exogamous and kinship was unilinear-patrilinneal. Through the shift to endogamy (marriage between close kin) there was a shift from uniliney (patriliniey) to bilinearne descent. This may have increased the probability of a recessive gene transmission from both parental sides. This is evidenced by the high inbreeding coefficient of 0.0687, one of the highest recorded.

Key Words: Hereditary, blindness, endogamous marriage, spouses, Jordan.
INTRODUCTION
Consanguineous marriage is the dominant marriage pattern in whole Jordan, reaching up to 63% of all marriages. Within this pattern, marriage between cousins and particularly first cousins predominant reaching an average of 38%. Variations are found between urban and rural areas. Continuity of marriage between cousins throughout the successive generations seems to have led to genetic impoverishment resulting in various kinds of mental and genetic physical deformation.

There is a lot of published scientific information on marriages among relatives and the resultant negative effects including their generation of genetic illnesses. Cavalli-Sforza and Bodmer affirm that endogamy, particularly the marriage of close cousins is an important social factor in causing the appearance of genetically determined illnesses. This is particularly evident in the case of recessive alleles so that the genetic units existing in single forms are transmitted through marriage in the form of pairs. Some studies show that marriage among relatives is still encouraged in certain societies resulting in the emergence of genetic illnesses, such as disorders of the ear, blindness, mental retardation and malformation. Other studies provide evidence that endogamous marriage in the Third World forms one of the main reasons for various health problems. El-Najjar reported that endogamous marriage, especially marriage between cousins which is preferred among Kuwaitis was the cause of mental retardation and physical deformities such as deafness and blindness, which is as much as 59.1% of the sample, as compared with 5.1% among foreign residents of Kuwait. Other studies from nearby Saudi Arabia showed a strong correlation between consanguinity and hereditary hearing disease among the newborn.

Hypotheses
On the basis of the information we gathered in the field showing that endogamous marriage (particularly patrilineal cousins marriage) was the most common marriage pattern, the following hypotheses were formulated: Endogamy lead to genetic isolation; Genetic distance increases proportionally with the increase of exogamous marriage and decreases proportionally with increasing endogamy which at a given stage, leads to coincidence of patriliny and matriliny; In the latter case the probability that genetically determined deviance (genetically determined illness), in this case blindness, increases more than in normal kin marriage relations as either patriliny or matriliny. Genetic studies made it obvious that genetic diseases are transmitted to children from their parents. Where these diseases exist they are transmitted through the recessive genes or alleles, especially when two mating individuals carry the same allele on the same locus.

METHODS
In this study, the genealogical method was used to trace descent and the degree of relationships in marriages among Al-Gharahgir tribe. Through several repeated visits during the summer months of 1996, the researchers (a biological and a social anthropologist) made comprehensive genealogical survey among the tribesmen by means of personal interviews with key informants selected carefully on the basis of their knowledge of the oral history of the tribe. This tribe, inhabiting the Sawalha village was chosen after a survey on possible hereditary diseases was conducted by the authors in the Jordan Valley, a large area known for the high incidence of consanguineous marriages. At the end, a genealogical tree of the whole tribe was designed and the researchers went back to check on correctness, validity and completeness. Afterwards, cases of blindness were traced back in ascendance to outline the degree of
consanguineous marriages as in the six samples shown in this paper. The inbreeding coefficient for each case was then calculated based on Cavalli-Sforza and Bodmer. In addition, a counting process was applied to draw the distribution of marriages by clan exogamy and endogamy, by endogamous marriages, by clan and degree of kinship between spouses.

Our example comes from the Jordan valley. The research was carried out among Al-Gharaghir, a tribe living in a town called Al-Sawalhah lying midway between the Dead Sea and Tiberias Lake. This is a tribe of about 2000 whose livelihood comes primarily from agriculture. Their common ancestor, known as Mohammed Waheed, is said to have come to the region in the first half of the 19th century, married into the tribes living there and settled permanently. His nickname was Gharghur (singular) and his sons got the same nickname Gharaghir, (in the plural). He, Gharghur, had three sons: Ibrahim, Qassem and Abdullah who became the grandfathers of the three clans of Al-Gharaghir tribes.

Endogamous (consanguineous) marriage among them appears to have led to genetically caused blindness as a result of genetic deformation (according to medical reports) in the iris and the retina.

RESULTS
The number of children in the Gharagir tribe is 823, twenty-two of them are blind (27/1000). In fact, all blind children were examined clinically by Professor Mahmoud Al-Salim, Head of the Department of Ophthalmology at the Jordan University of Science and Technology and found that a recessive gene effecting both the iris and the retina inherited the disease.

Table 1 shows clearly that the average endogamous marriage through the seven generations that were traced genealogically in an ascending order is 60.4% for clan 1, 51% for clan 2 and 55.5% for clan 3. The average was 55.6%.

Table 2 shows that there had been a shift from exogamous to endogamous marriage. In the clan, the first three generations had exogamous marriages while in the fourth generation, the tribe members started to intermarry and continued to do so in the succeeding generations. This seems to have led to genetic enclosure, when there was a shift from unilineal (partilineal) to bi-lineal kinship where patriliny and matriliny conjoined.

Table 3 shows that marriage between cousins of the first degree is the highest while that between cousins of the second degree occurs less frequently than marriage between cousins of the third and fourth degrees. Marriage between cousins forms 39.1% of marriages between relatives while it is 20.3% of all occurring marriages.

The two blind people B1 and B2 (Figure 1) are the result of a marriage between cousins...
Table 2: Distribution of marriages by generation, and exogamous marriages

| Generations | Clan 1 % | Clan 2 % | Clan 3 % |
|-------------|----------|----------|----------|
| 2           | 100      | 100      | 100      |
| 4           | 57.9     | 42.1     | 16.6     |
| 5           | 69.1     | 30.9     | 66.6     |
| 6           | 62.2     | 37.5     | 66.6     |
| 7           | 55.8     | 44.2     | 85.7     |
| 8           | 33.3     | 66.6     | 13.3     |

Table 3: Distribution of Endogamy among the Gharghir Tribe by clan and degree of relationship

| Clan       | C1 % | C2 % | C3 % | C4 % | C5 % | Total |
|------------|------|------|------|------|------|-------|
| Ibrahim    | 31.1 | 5.1  | 15.0 | 10.3 | 9.2  | 92.7  |
| Qassim     | 11.1 | 1.2  | 5.0  | 2.2  | 5.7  | 23.1  |
| Abdullah   | 12.1 | 2.1  | 3.0  | 5.0  | 2.1  | 23.2  |
| Total      | 54.1 | 7.2  | 21.0 | 28.0 | 20.3 | 138.5 |

Figure 1: Genealogies of the blind B1-B8

of the first degree. The father and mother are the result of marriages between cousins of the 3rd and 4th degrees respectively. They are related bilineally. So were the parents (in the third ascending genealogically related clans) who trace descent back to the same common ancestor (Figure 2). Marriage between cousins of 3rd degree produced blindness just as marriage between cousins in the 4th degree did in the case of blind B4-B8. Yet the marriage between cousins of the first degree which produced B3 had spouses who were descendents of parents themselves cousins of the 1st degree once removed in the mother’s line. Heredity in all the three examples was not only matrilineal, but also bilineal. Both the father and mother trace their descent back to one common ancestor in the 5th ascending generation from ego B. Both spouses in all three generations in the majority of marriages are traceable bilineally to one common ancestor. The shift from patrilineal exogamy to bilinear endogamy is seen clearly in this model.

As in the previous example, this model shows exogamous marriage in the first three generations, except for one marriage between cousins in the third generation, which is a marriage between cousins of the 1st degree. In the fifth generation, there is one marriage between cousins of the 1st degree, which produced the three blinds B9-B11. It seems evident that the consanguinal relations are mostly bilineal for both clans A and B in the formally classified partilneal group. Marriages in the first three ancestral generations were exogamous and the shift to bilinear kinship is very clear in the later generations.
Figure 3 shows clearly that there are no consanguineous marriages in the first four ancestral generations. In the fifth generation, we found one consanguineous marriage between 1st degree cousins, which produced the blinds B12-B13. Similarly, the exogamous marriage in the first four generations did not prevent the manifestation of blindness in the children resulting from the marriage of cousins of the 1st degree in the sixth generation. At first sight, this diagram may appear to contradict our hypothesis but further analysis proves that because the recessive gene is transmitted patrilineally, the shift to bilineal descent within the patrilineal group through endogamous marriage is likely to increase the probability of malformation.

In figure 4, marriage between cousins of the 1st degree in the sixth generation, which resulted from successive marriages between 1st degree cousins in previous marriages produced blindness in B14 -17. This example makes it clear that the genetic defect that ran through patrilineal descent in both clans A and B was enhanced by the shift to bilineal descent. The shift in this diagram starts from the second descending generation.

**Figure 2: The Genealogy of B9-B11**

**Figure 3: Genealogy of the blind B12-13**

In this model we find the marriage of two cousins once removed in the fifth and seventh generation. Despite the fact that the wife in one of the marriages in the fifth generation is a foreigner (exogamous marriage), the cousins’ marriage once removed produced the blinds B18-B20. As in the previous models, consanguinity passed patrilinealy, while the shift to bilineal descent started from the second descending generation.

Figure 6 shows one consanguineous marriage in the third generation and the marriage of two cousins in the fourth generation,
one of which is of the first degree and the other of the second degree. The fifth generation contains a marriage between a fourth degree cousins. In the sixth generation, the marriage between cousins of the 1st degree produced two blind infants B21 and 22. The shift to bilineal descent starts in the third descending generation.

**DISCUSSION**

Consanguineous marriages are still widely practiced in many countries of the third world particularly in Moslem Arab countries.\textsuperscript{18-21} This type of mating, especially marriage between cousins of the 1st degree remains an important social cause of hereditary abnormalities particularly in the case of recessive genetic traits.\textsuperscript{7} Consanguineous mating is known to cause an increase in recessively transmitted diseases, congenital malformation, infant mortality and mental retardation.\textsuperscript{8-9} For example, Freudlich and Hino\textsuperscript{17} reported a percentage of consanguineous
marriages among Arabs living in the rural areas of Galilee in northern Israel, of up to 37% including those between cousins of 1st and 2nd degrees. Another sample, consisting of 1,546 children from the same region, Gevi et al.18 found 32% of the offspring the product of consanguineous marriages between cousins of the 1st and 2nd degrees. El-Alfi et al report the percentage of consanguineous marriage among Kuwaitis to be as high as 53.9%.22 Hamamy et al19 put nearby Iraq among the highest in the world (ca 70%) except for perhaps strongly isolated societies with a high genetic load. The incidence of consanguinity in recent generations has greatly declined in many parts of the world. This is particularly true of the United States and Western Europe, where the incidence of marriages between first cousins in the general population is approximately 0.5%. A large amount of published information show the adverse effects of consanguinity on offspring. However, genetic and demographic studies show that within many large human populations, consanguineous marriages are still strongly favored.23 For example, in the mainly Moslem countries of North Africa and Western Asia, including India and middle Asian countries of the former Soviet Union, marriages contracted between persons who are second cousins or closer, account for 20% to 55% of the total number of marriages.24

In Jordan, consanguineous marriages are still predominant reaching up to 63%.1, 2 Marriages between cousins of the 1st degree account for 38.7% of this. In the sample of Algharaghir, it is clear that the occurrence of consanguineous marriages in successive generations has strongly affected the inbreeding coefficient. Khory and Massad3 and Al-Salem and Rawashdeh1 report an inbreeding coefficient for the general Jordanian population of 0.0283. The inbreeding coefficient in our sample is far higher and varies from 0.037 to 0.09374 giving an average of 0.0687.

The literature so far reviewed speaks of actual consanguineous mating. The question arises as to whether the actual accidental marriages between cousins is responsible for such harmful effects as malformations of different types. Our sample shows clearly that the generation of genetic malformation of inbreds is more or less conditioned by successive 1st degree cousin marriages for many generations transforming patriliny or matriliny to bilineal non-prescribed rule. Our view is that this transformation increases the likelihood of the disease manifesting when two people carrying the same recessive alleles mate.

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