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A PHENOTYPICALLY NORMAL FEMALE GOLDEN HAMSTER WITH SEX-CHROMOSOME ANOMALY[1)]

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Within the last decade, rapid advances of cytological techniques have made it possible to detect significant associations of sex anomalies with sex chromosome abnormalities in mammals including man. Despite of frequent occurrence of intersexuality in domestic mammals, knowledge on their cytogenetic features has remained very meager. Chromosomal conditions of domestic or laboratory animals are the subjects of particular interest in relation to sexual maldevelopment and sex-chromosome abnormalities of mammals. An opportunity arose to investigate a case of phenotypically normal female golden hamster (*Mesocricetus auratus*) associated with an anomalous sex-chromosome constitution, the data of which is presented in the present paper.

MATERIAL AND METHOD

While working on DNA synthesis pattern of female somatic X chromosomes in the golden hamster, an unusual female with only one X chromosome was found incidentally. This animal was derived from a random-bred albino strain maintained in our laboratory. The external features of the animal did not show any deviation from normal healthy adult females, with a normally developed vaginal opening. Internal sexual organs were also of normal female type showing a well-developed bipartite uterus with bilateral ovaries and oviducts (Fig. 1). Histological examinations revealed that the ovaries were apparently morphologically and functionally normal, containing a number of mature and immature oocytes (Fig. 2). Even one discharged egg together with a number of follicular cells was found in the serial sections of the right oviduct (Fig. 3). On scanning the serial sections of ovaries no testicular structure or its remnants were detected. Thus the possibility of ovotestis was excluded.

Fig. 1. Photomicrograph of internal genital organs of the female golden hamster under study, showing a well-developed uterus with bilateral ovaries and oviducts.

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As mentioned above, chromosome slides of the present specimen were made primarily for autoradiographic studies of bone marrow celles. Marrow cells from the femur were aspirated into a centrifuge tube containing 8 ml of culture medium, 2 ml of calf serum and 10 μc ^{3}H-thymidine, and incubated for 6 hours at 37°C with 10^{-7}M colchicine for the final 2 hours. Then, they were pretreated with hypotonic KCl solution (0.075 M) for 20 minutes at room temperature, fixed in Carnoy's solution, air-dried and stained with carbol fuchsin. The slides thus made were further processed for autoradiography, but the cells did not show adequate grain density due to some unknown reason. Despite the poor quality of the slides for autoradiographical studies, a considerable number of metaphase cells were available for karyotype analyses.

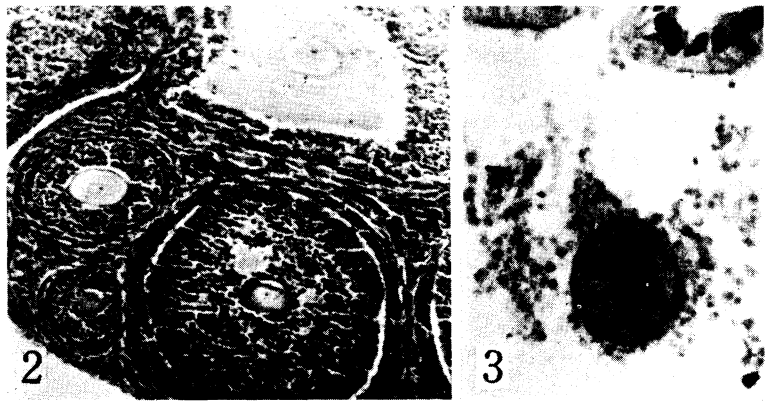

Fig. 2. Histological features of the ovary, showing apparently normal oocytes of various stages. ×100.

Fig. 3. An apparently normal ovum and surrounded follicular cells found in the right oviduct. ×400.

CYTOLOGICAL FINDINGS AND REMARKS

The chromosome number, as determined from 50 excellent metaphase plates, was 44 without exception. All the 50 metaphases analysed had a single X chromosome which was the largest metacentrics of the complement and was readily distinguishable from others. Karyotypes were arranged from several good plates in accordance with a similar scheme published by Lehman *et al.* (1963). As shown in Fig. 4, the somatic karyotype of the present specimen was superficially indistinguishable from the normal pattern of the species. Considering that polymorphism for the Y chromosome appears to exist in the golden hamster (Lehman *et al.* 1963), the identification of the Y chromosome was carried out in bone marrow cells of a male from animals of the same stock. The morphological and autoradiographical studies revealed that the Y chromosome of the animals of our stock was one of the largest submetacentrics which was similar in size and shape to the autosomes 1-2. In the male complement the long arm of the X chromosome and the entire Y chromosome were late replicating, as has been reported by Galton and Holt (1964).

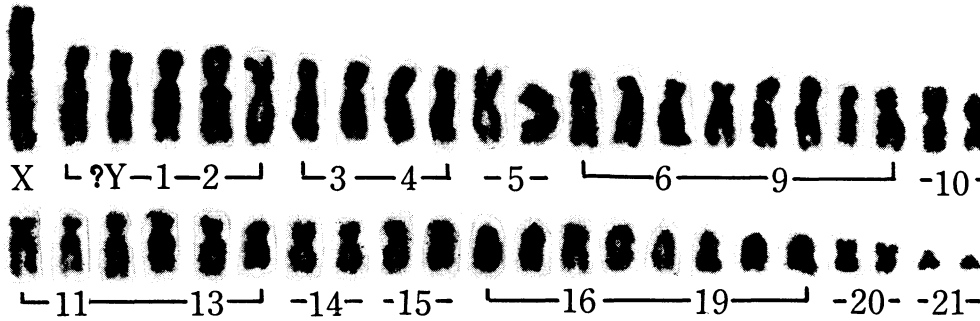

Fig. 4. Karyotype from a bone marrow metaphase with 44 chromosomes, which is superficially indistinguishable from the normal male pattern.

Recent cytogenetic literature in human and several mammalian species has provided evidence that the mammalian Y chromosome generally carries a male determining gene (or genes) essential for the testicular development. Assuming that this is correct, it is unexplicable that the phenotypically normal female animal in the present study, with apparently functional ovaries, showed an XY sex-determining mechanism. Several cases of intersex domestic mammals with an XY sex chromosome constitution have been reported in cattle, dogs and rabbits, all showing testicular structure, like the testicular feminization syndrome in man (Nes 1966; McFeely *et al.* 1967; Shaver 1967). But there have been cases reported of intersex in goats and pigs with male gonads showing an XX sex chromosome constitution (Makino *et al.* 1962; Basrur and Coubrough 1964; Hard and Eisen 1965; McFeely *et al.* 1967). Ferguson-Smith (1966) suggested the interchange of a male determining gene (or genes) of the Y chromosome onto the paternally derived X chromosome for similar cases of intersex in man. A similar change might have occurred in our case, where the Y chromosome had lost the male determinants by the paternal meiotic crossing over between the X and the Y. Such a chance, if any, might be expected to occur more frequently in golden hamsters than in man, as chiasma formation between the X and Y chromosomes has been observed in the male meiosis of the golden hamster (Koller 1938; Emmons and Husted 1962), whereas in the human male the X and the Y are seen associated end-to-end without forming chiasma between them (Sasaki and Makino 1965).

Also the possibility that the presumptive Y chromosome in the present case was not the Y but a deleted X produced probably as a result of a partial short arm deletion cannot be ruled out. The short arm deletion or entire lack of an X chromosome has been reported in some infertile human females with gonadal dysgenesis, while in the mouse the XO individuals are normal and fertile females. If the same situation occurs also in the golden hamster, then the interpretation of the short arm deletion of an X chromosome may be justified for the present case.

Further detailed cytogenetic studies are essential in the golden hamster as well as in other mammals for the understanding of the genetic mechanism of sex determination and sex differentiation.

SUMMARY

An anomalous sex-chromosome constitution was observed by chance in a case of phenotypically normal female golden hamster. Bone marrow metaphases of this animal showed 44 chromosomes with a karyotype which was indistinguishable in general appearance from that of the normal male. Two tentative interpretations were made for the sex-determining mechanism of the present specimen: one is the XY constitution in which the Y chromosome had lost its male factors due to the interchange of genetic materials between the X and the Y at the time of meiotic segregation, and the other deals with a partial short arm deletion in one of the two X chromosomes.

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