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A silver-staining study of the nucleolus organizer regions
of the chromosomes of domestic sheep (Ovis aries)

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ABSTRACT

A study was made of various aspects of the nucleolus organizer regions (NORs) on sheep mitotic chromosomes, using the Ag-AS and Ag-I techniques. The sheep used in this study were carriers of the t_1 , t_2 and t_3 Robertsonian translocations in various heterozygous and homozygous combinations. The locations of the NORs were determined to be at the telomeres on the metacentric chromosomes 1p, 2q and 3q and on the acrocentric chromosomes 4 and 25. The identity of the NO-chromosome was confirmed by a duplicate G-banding and Ag-I technique. The terminal location of the NORs indicates that they do not have a causative role in acrocentric association or Robertsonian translocation in domestic sheep. They also do not coincide with the regions in which secondary constrictions are sometimes seen.

Individual animals were found to have a characteristic silver-staining pattern. The chromosomal distribution of the Ag-staining NORs (Ag-NORs), the frequency and size of the Ag-NORs were fairly constant in different cells of an individual and in replicate cultures of an animal. Differences between cells and replicates in Ag-staining involved variation in the frequency of staining of Ag-NORs with small Ag-deposits. Overall, the metacentrics had the highest frequency of Ag-NORs, followed by chromosome 25 and then chromosome 4.

The association frequency of individual NO-chromosomes was found to be positively correlated with the frequency of Ag-NORs and the size of the Ag-deposit. The frequency of each pairwise combination of associating chromosomes was determined solely by the frequency of Ag-NORs of the component chromosomes. No evidence was found for a non-random fusion of NORs. These observations provide an explanation of the reports of non-random participation of acrocentric chromosomes in satellite association in man. The increased association of NO-chromosomes with large deposits could be due to an increased chance of fusion of larger nucleoli or to differences in the disintegration rate of different sized nucleoli.

The presence of a NOR on the chromosome 25 / t_3 polymorphism was utilized in inheritance studies of Ag-stainability. Five pedigree groups in which this chromosome was segregating were studied and in all cases the size of the Ag-deposits and frequency of staining was consistent between consecutive generations. The value of Ag-staining in genetic mapping studies is discussed.

In 3 animals, the Ag-staining patterns of transformed lymphocytes and fibroblasts were compared and found to be similar.

A comparative study was made of 5 species of the Bovidae: domestic sheep (Ovis aries), domestic goat (Capra hircus), aoudad (Ammotragus lervia), bharal (Pseudois nayaur) and cattle (Bos taurus). Five NO-chromosome pairs were found in sheep, goat, aoudad and cattle and these chromosomes have homologous banding patterns. The bharal has at least four NO-chromosome pairs homologous to sheep. These results indicate a conservation of the NORs during evolution in this family.

Based on the results of the frequency of Ag-staining of NORs, the heritability of Ag-stainability and the constancy of Ag-staining patterns found in the tissue studies, the nature of the Ag-staining is discussed and a model on the basis of the Ag-stainability of individual chromosomes is presented.

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