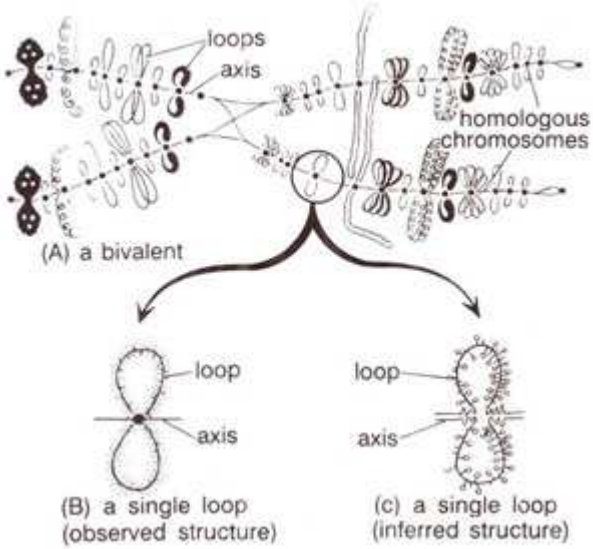
Special types of chromosomes

- The preceding section in this section dealing with chromosomes in eukaryotes was devoted to structure and function of chromosomes as observed in mitotic or meiotic cells in plants and animals. In certain organisms there are special tissues where these chromosomes take up a special structure. **Lampbrush chromosomes** of the vertebrate oocyte and **giant chromosomes** of salivary gland cells of dipterans are such special types of chromosomes.

Lampbrush chromosomes

- As indicated earlier, chromosome structure at the same stage of cell division remains constant in the different kinds of cells in the same organism. Chromosomes of a special kind are, however, found in a variety of primary oocyte nuclei in vertebrates (mainly amphibians) as well as in some invertebrates. These chromosomes, known as lampbrush chromosomes, are found during the prolonged diplotene stage of first meiotic division in primary oocytes of amphibians, and in spermatocyte nuclei of *Drosophila.*
- The lampbrush chromosomes are characterized by a remarkable change in structure. The change in structure includes an enormous increase in length. These chromosomes sometimes become even larger than polynemic giant salivary gland chromosomes. The largest chromosome having a length upto 1 mm has been observed in urodele amphibian. The chromosomes seem to have a chromomeric pattern with loops projecting in pairs from majority of chromomeres. One to nine loops may arise from a single chromomere. The size of loops varies with an average of 9.5μ in inter-chromomeric fibres. These pairs of loops in these chromosomes give them the characteristic lampbrush appearance (Fig.). Frequently these loops exhibit a thin axis (which probably consists of one DNA double helix) from which fibres project which are covered with a loop matrix consisting of RNA and protein.
- The number of pairs of loops gradually increases in meiosis till it reaches maximum in diplotene. As meiosis proceeds further, number of loops gradually decreases and the loops ultimately disappear due to disintegration rather than reabsorption back into the chromomere. H. Ris, however, had thought that the loops were integral parts of chromonemata which are extended in the form of major coils. It is also believed that the loops represent the modified chromosome structures at the loci of active genes. It has been observed that, if the activity of these genes is stopped by actinomycin D

(actinomycin D stops synthesis of RNA on DNA template), the loops will collapse, suggesting that the loops mainly consist of RNA.



Salivary gland chromosomes- Polytene Chromosomes

- In salivary gland cells of dipteran species, giant chromosomes were observed By **E.G. Balbiani** for the first time in 1881. The availability of these chromosomes greatly helped the study of cytogenetics in fruitfly *(Drosophila).* These chromosomes may reach a size up to 200 times (or more) the size of corresponding chromosomes at meiosis or in nuclei of ordinary mitotic cells. Another characteristic of these giant chromosomes is that they are somatically paired. Consequently the number of these giant chromosomes in the salivary gland cells always appear to be half that in the normal somatic cells. The giant chromosomes have a distinct pattern of transverse banding which consists of alternate chromatic and achromatic regions. These bands have greatly helped in the mapping of the chromosomes in cytogenetic studies. The bands occasionally form reversible **puffs,** known as chromosome puffs or **Balbiani** rings, which are associated with differential gene activation.
- The giant chromosomes represent a bundle of fibrils which arise by repeated cycles of endo-reduplication of single chromatids. Endo-reduplication means that the chromatin replicates without cell division, as a result of which the number of chromonemata keeps on increasing. This is why these chromosomes are also popularly known as polytene chromosomes and- the condition is described as polyteny. The number of chromonemata (fibrils) per chromosome may reach upto 2000 in extreme cases. Some workers placed this figure as high as 16,000. In *D. melanogaster,* the giant chromosomes are found in the form of five long and one short strands radiating from

a single more or less amorphous mass known as chromocentre (Fig.). One long strand corresponds to the X chromosome and the remaining four long strands are the arms of II and IIIchromosomes. The centromeres of all these chromosomes fuse to form the chromocentre. In the male flies the Y chromosome is also found fused within the chromocentre and is therefore not seen as a separate strand. How an enormous increase in size of these chromosomes is brought about in salivary glands is not known and various hypotheses are available to explain this issue. The reader should consult Swanson's book, *Cytology and Cytogenetics,* to get a relatively detailed account of these hypotheses. It should, however, be emphasized that these giant chromosomes though, commonly found in salivary glands, have also been found in malpighian tubules, fat bodies, ovarian nurse cells, gut epithelia and some other tissues.