Giant chromosomes
Giant Chromosomes

There are chromosomes which are extremely large compared to normal chromosomes. Such chromosomes, called giant chromosomes occur in some animal cells. Two types of giant chromosomes are known:

- Lampbrush Chromosome
- Polytene Chromosome
Lampbrush chromosomes

• These chromosomes occur in the oocytes (germ cells in the ovary) of amphibians and in fishes, reptiles, birds and in some insects.
• They are extremely large synapsed homologous chromosomes, seen in the diplotene stage of prophase-I in meiosis.
• They measure about 1500 to 2000 micrometer in length as opposed to 15–20 μm during later stages of meiosis.
• first discovered by Flemming in 1882
Lampbrush chromosomes

- The amphibian oocyte (immature egg) has certain periods of very active RNA synthesis.
- This stage can last several months.
- Lampbrush chromosomes are extended chromosome bivalents.
- Lampbrush chromosomes are highly active in RNA synthesis, and they form unusually stiff and extended chromatin loops that are covered with newly transcribed RNA packed into dense RNA-protein complexes.
lamp brush chromosomes

- The paired chromosomes of oocytes in meiosis consist of numerous chromatin loops arranged along an axis. Chiasma formation is visible at various locations.
- Each segment of a lampbrush chromosome consists of a series of chromatin loops, originating from an axis and a condensed structure, the chromomere along the axis.
- The loops consist of transcriptionally active DNA which can synthesize large amount of mRNA, necessary for the synthesis of yolk.
- About 5 to 10% of the DNA is in the lateral loops. Lampbrush chromosomes (amphibian oocyte, immature eggs)
lampbrush chromosomes

• Transcription occurs either along the whole loop or at parts of a loop.
• The chromatin loops of a chromosome are paired, mirror-image structures, each corresponds to the loop of a sister chromatid.
• The chromomere at the base of the loops consists of dense chromatin of the two sister chromatids.
• At the beginning of meiosis, when DNA replication is complete, the homologous pairs lie immediately next to each other and form characteristic structures composed of four chromatids.
• Lampbrush chromosomes are distinguished by an especially high rate of RNA transcription.
lamp brush chromosome

Loops

Central axis
1. Paired lampbrush

2. Enlarged section of a chromosome

3. Section of a chromosome loop

4. Photograph of a lampbrush chromosome

- Chromosome structure in amphibian oocytes ("lampbrush chromosomes")
A general chromosome model

• A general chromosome model based on these studies has been proposed in which loops of 30-nm fibers extend at an angle from the main axis of the chromosome
• These **lamp brush chromosomes** can be revealed as the sites of RNA synthesis by in situ hybridization. Oocyte chromosomes can be incubated with a radioactive RNA probe.

• **Autoradiography** can be used to visualize the precise location where the gene is being transcribed.
Polytene Chromosomes

• Chromatin structure is also unusually visible in certain insect cells. Many of the cells of the larvae of flies grow to an enormous size through multiple cycles of DNA synthesis without cell division. The resulting giant cells contain as much as several thousand times the normal DNA complement.

• In several types of secretory cells of fly larvae, all the homologous chromosome copies are held side by side, creating a single giant polytene chromosome.

• These chromosomes, first observed in cells of insect salivary glands of *Drosophila*.
Polytene Chromosomes

- Found in salivary glands and other tissues of flies
- Seen in the nucleus during interphase
  - reaching a length of 2000 μm
- Show linear series of alternating bands and interbands,
- There is a distinctive banding for each chromosome in a given species
Polypene Chromosomes

- A polypene chromosome results from ten cycles of replication without division into daughter chromosomes.
- Thus, there are about 1024 identical chromatid strands, which lie strictly side by side.
- Contain five long and one short arm radiating from a central point called chromocentre, formed by the fusion of centromeres of all the eight chromosomes found in the cell.
- Of the 6 arms, the short arm represents the fused IV chromosome and the longest represents the fused sex chromosomes.
- About 80% of the DNA in polypene chromosomes is located in bands, and about 15% in interbands.
- The chromatin in the darkly stained band is condensed to a much greater degree than the chromatin in the interbands.
- Intensely stained chromosomal segments correspond to a high degree of packing and are genetically inactive (heterochromatin);
- less packed segments stain less distinctly and correspond to segments with genetic activity (euchromatin).
Functional stages in polytene chromosomes

- Polytene chromosomes form structures that correlate with the functional state.
- During the larval development of drosophila, a series of expansions (puffs) appear in temporal stages in the polytene chromosomes.
- Chromosome puffs are decondensed, expanded segments that represent active chromosomal regions, i.e., regions that are being transcribed.
- The location and duration of the puffs reflect different stages of larval development.
- The incorporation of radioactively labeled RNA has been used to demonstrate that RNA synthesis, a sign of gene activity (transcription), occurs in these regions.
1. Formation of puffs (arrows)

2. Evidence of gene activity

B. Functional stages in polytene chromosomes
Model of RNA synthesis in Chromosome puffs
RNA synthesis in Chromosome puffs
Red: newly synthesized BrUTP; Blue: old ones diffused