Polytene Chromosomes

The secretory cells of certain fly larvae grow to an enormous size and undergo multiple rounds of DNA replication without cell division. As a result, these giant cells contain many thousands of times the normal amount of DNA—termed polyploidy. Side by side, these DNA molecules line up and remain attached forming what is known as a polytene chromosome (Figures 1 and 2).

Polytene chromosomes are easily visible under the light microscope due to their enormous size (Figures 2 and 3). In the *Drosophila* species, polytene chromosomes represent 10 rounds of DNA replication, and each structure has 1024 (2^{10}) identical strands of DNA. The light and dark bands that are visible when looking at polytene chromosomes under the light microscope are thought to represent either a high concentration of proteins, highly condensed chromatin, or both of these structural features (Figures 1,2 and 3).

Polytene chromosomes in *Drosophila* have other features which are visible under the light microscope as well. The insect steroid ecdysone controls the expression of genes involved in larval molting and pupation. When this hormone is present at high levels, as is normal during larvae development, chromosomal "puffs" can be seen (Figure 3). It is thought that most puffs arise from the relaxing and decondensing of individual chromosomal bands in the polytene chromosome. When we perform our laboratory activity, we will be examining the salivary glands of several *Drosophila* species.

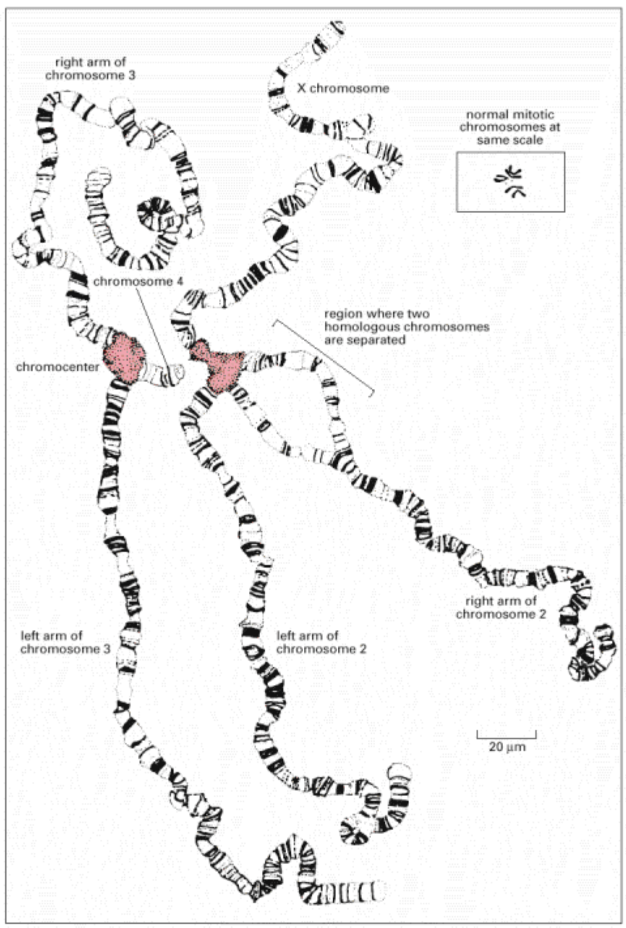

Figure 1. The entire set of polytene chromosomes in one *Drosophila* salivary cell. These chromosomes have been spread out for viewing by squashing them against a microscope slide. *Drosophila* has four chromosomes, and there are four different chromosome pairs present. But each chromosome is tightly paired with its homolog (so that each pair appears as a single structure), which is not true in most nuclei (except in meiosis). The four polytene chromosomes are normally linked together by regions near their centromeres that aggregate to create a single large chromocenter *(pink region)*. In this preparation, however, the chromocenter has been split into two halves by the squashing procedure used. (Modified from T.S. Painter, *J. Hered.* 25:465–476, 1934.)

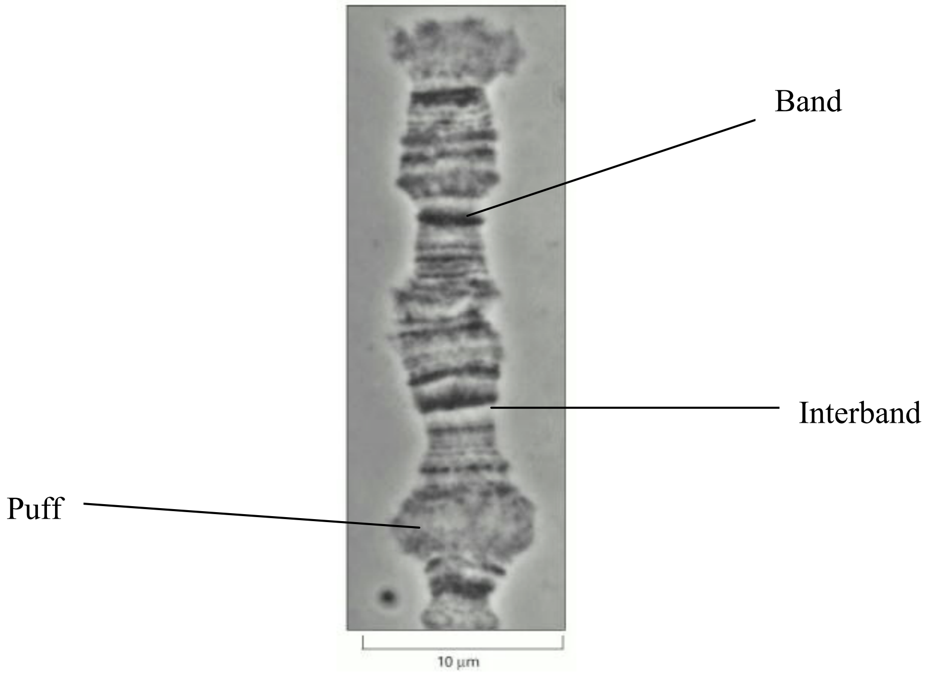

Figure 2. A light micrograph of a portion of a polytene chromosome from *Drosophila* salivary glands. The distinct pattern produced by bands and interbands is readily seen. The bands are regions of increased chromatin concentration that occur in interphase chromosomes. Although they are detectable only in polytene chromosomes, it is thought that they reflect a structure common to the chromosomes of most eucaryotes. (Courtesy of Joseph G. Gall.)

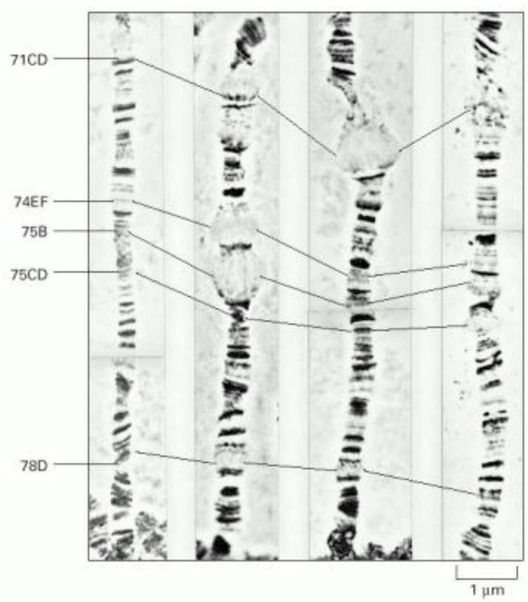

Figure 3. Chromosome puffs. This series of time-lapse photographs shows how puffs arise and recede in the polytene chromosomes of *Drosophila* during larval development. A region of the *left* arm of chromosome 3 is shown. It exhibits five very large puffs in salivary gland cells, each active for only a short developmental period. The series of changes shown occur over a period of 22 hours, appearing in a reproducible pattern as the organism develops. The designations of the indicated bands are given at the left of the photographs. (Courtesy of Michael Ashburner.)

References:

Alberts, Bruce, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, and Peter Walter. *Molecular Biology of the Cell*, 4th Ed. Pp. 218-222. New York: Garland Science, 2002.