

TRANSCRIPT

Course: Diversity of Chordates & Genetics (ZOC-102)

Unit 09: Chromosome Structure

Module: Giant Chromosome- Polytene Chromosome

Module No: 14

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Welcome to this course on 'Diversity of chordates and Genetics' from Bachelor of Science in Zoology of Semester 2. The paper code is ZOC-102, and I'll be speaking on the module 'Giant chromosome - Polytene chromosome' from unit 9 -Chromosome Structure.

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The outline of my presentation: Polytene chromosome, it's brief history, its structure and the functions. Upon completion of this e-learning content, the student should be able to explain the structure of the polytene chromosome and its function; and also discuss the significance of the polytene chromosome.

Introduction:

A polytene chromosome is another type of giant chromosome. They are gigantic interphase chromosomes, which have multiple DNA strands. They have thousand times more DNA than the normal somatic chromosomes. And they provide high level function in some other tissues, especially in the salivary glands of some insects.

Brief History:

It was first reported by *Edouard Gerard Balbiani* in 1881. He observed this polytene chromosomes in the salivary glands of Chironomous larva. In 1935, *PC Koller*, introduced the term 'Polytene' to describe this giant chromosome.

The relationship between the polytene chromosome and the regular mitotic chromosome, was first proposed by *Rambousek* in 1912 and then by *Koltzoff* in 1934 and Bauer in 1935.

Occurrence:

'Polytene chromosome' occurs in the salivary glands of many of the insects and therefore it is also referred to as a 'salivary glands chromosome'. It is the largest polytene chromosome described thus far in the salivary glands, of *chironomid genus*. It is also seen in the protists, plants and some mammals. In some insects, it is also found in the malphigian tubules as well as in the fat bodies. They are visible under the compound microscopes during the interphase stage because of their enormous size.

Structure:

They have a size which varies from 0.5 mm in length to 20 micrometer in diameter and can reach up to around 200 micrometers in length. The large size is rendered on account of duplication of the *chromonemata* without separation. The chromosomal strands are formed by 'endomitosis', which means, they undergo repeated divisions, but there is no cell nuclear division. Therefore, it results in a polyploid cell. Thus, it has multiple strands or chromatids, and therefore the name 'Polytene chromosome'.

- ✓ A Polytene chromosome(refer image) has a central point called '*Chromocentre*'. From this chromocentre, 6 arms radiate. Of these 6 arms, 5 arms are longer, and one arm is short. This short arm is derived from chromosome-4(refer image).
- ✓ This is the actual image (refer image) of the polytene chromosome which is seen in the salivary glands of *Drosophila*. You can see that the central region will be the *chromocentre* and from the *chromocentre* you find that there are various arms which arise viz. five long arms and one short arm.
- ✓ There are six arms which are present in the polytene chromosome. The short arm is actually the fusion of two chromosome, viz. Chromosome 4. The long arms are fusion of different chromosomes. So we have here (refer image) the long arm left arm of chromosome 3 and the right arm of chromosome 3; Left arm of chromosome 2 and the right arm of chromosome 2 and both the X chromosome again fuse to form a single arm.
- ✓ These arms show light and dark bands. We have the whole chromosome (refer image) showing different regions, viz. Light and dark bands. What are these light and dark bands? The dark bands are intensely stained regions and they represent the *heterochromatin*. These are referred to as 'bands' and are genetically inactive regions. The lighter regions which you see here (refer image) are referred to as the 'Inter bands' and they represent the *euchromatin*. These regions of *euchromatin* are genetically active regions, so on staining the chromosome appears to have alternate dark and light band pattern. 80% of the DNA occurs in the dark bands, whereas 20% of the DNA occurs in the light bands.
- ✓ Dark bands have a high amount of histone. So Dark bands basically will be the non active region and the light bands, are the regions of active transcription. So the Dark bands are darkly stained and we can say that there is more DNA presents there and less RNA, which means they do not undergo transcription.
- ✓ 'Interbands', are lightly stained and they contain more RNA and less DNA, which means that they are sites of active transcription.
- ✓ Puffs- Some of the bands they show these region which are referred as chromosomal puffs(refer image). What are chromosomal puffs? They are the light band region which temporarily swells up and form enlargements. This puffed region is referred to as a 'chromosomal puff or 'Balbiani ring'. This is a unique component which is present in the polytene chromosomes. The largest puffs were observed by Balbiani in 1881 in the *chironomus* larva. Puffs are series of relatively achromatic swollen segments that are

active regions of RNA synthesis. These puffs may appear and disappear based on the requirement of specific protein which need to be secreted. So you can see here that if you're enlarge the image of this 'puff' region(refer image), it has the appearance like this. So the bands of the polytene chromosome, may become enlarged to form this 'puff' and the process by which the puffs occur is referred to as 'puffing'. in the region of the puffs, the chromonemata which is seen is uncoiled and opened up. Therefore you can see the puffed up region as 'chromosome puff' or 'balbiani rings'. So uncoiling of individual chromomeres in a band causes the puffing. The puff indicates that this is a site of active genes, where mRNA synthesis is taking place. For example, when the ecdyson hormone is required for the process of moulting in the insects, it stimulates the formation of balbiani rings or the puffs. This is the image of the polytene chromosome (refer image). In the scanning electron microscope image (refer image), here you can see the puffed region that is a chromosome puffs and you can see the light regions present here.

Function:

- ✓ So Polyteny is a mechanism which caters to rapid development of an organ, especially when an organ containing cells with **polytene** chromosomes are involved, there is an intense secretory function associated with it.
- ✓ **Polytene** chromosomes are also concerned with metamorphosis, which takes place in the insects. For example, ecdyson hormone or the moulting hormone, which is present in the insect stimulates the formation of balbiani rings in the bulletin chromosome.

Similarities between the Polyteny chromosome and Lampbrush chromosome:

- ✓ *Similarities:*
 - *Lampbrush chromosome and Polytene chromosome, both are giant chromosome.*
 - *The extremely large as compared to the normal chromosomes which occur in the in the results.*
 - *These chromosomes can also be seen under the light microscope*
- ✓ *Differences:*
 - *They differ with respect to their appearance, their presence, the size and the structure.*
 - *Appearance: Polytene chromosome has six arms and they have a characteristic light and dark bands. Whereas Lampbrush chromosome does not show any banding pattern.*
 - *Presence: Polytene chromosome is present in the saliva glands of the Organism and it is seen in the interface or prophase stage of mitosis whereas Lampbrush chromosome is seen in the gametes(oocyte) in the diplotene stage of meiosis.*
 - *Structure: Polytene chromosome is a giant chromosome, but it is smaller than the Lampbrush chromosome (As compared to the Polytene chromosome. Lampbrush*

chromosome is larger). Polytene chromosome, is made up of multiple strands of DNA, which gives the large size. Whereas, the large size in the *Lampbrush chromosome* is rendered on account of its main axis, with large number of lateral loops.

So we can conclude saying that Polyteney arises and attains high level in the tissues, organs and at the developmental stages, when there is a need for rapid development of an organ or an unaltered high level of function. Organs containing the cells with polytene chromosomes are, as a rule, involved in intense secretory functions.

Thank you.