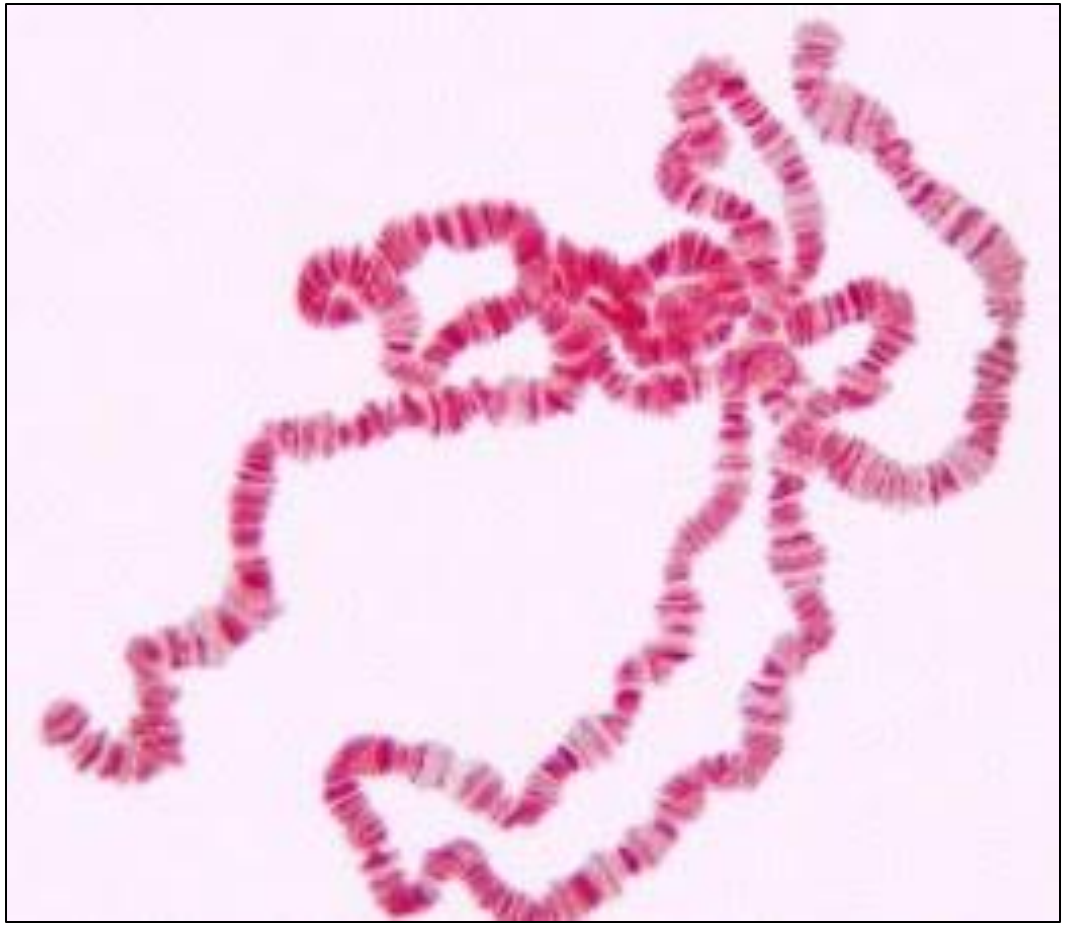
POLYTENE AND LAMPBRUSH CHROMOSOMES

What are these?

- Giant chromosomes (large sized)
- Can be both polytene (salivary gland chromosome) and lampbrush chromosomes



POLYTENE CHROMOSOMES

INTRODUCTION

- Discovered in the salivary glands of *drosophila* (therefore called salivary gland chromosomes)
- Also present in insects like mosquitoes
- Kollar gave the term "polytene chromosome" because of high DNA content
- Also occur in rectum, gut, foot pads, fat bodies etc.

HOW ARE THEY FORMED?

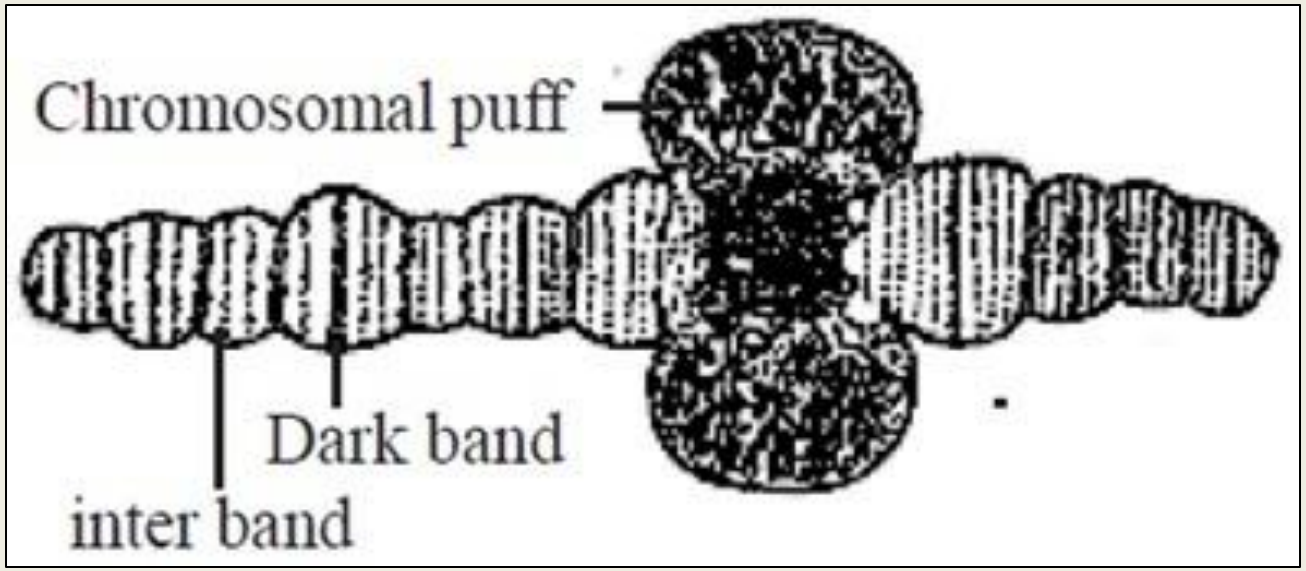
- Replication of chromosomal DNA several times
- Without nuclear division
- Resultant chromatids do not separate and remain joined side by side

POLYPLOIDY: excess DNA in nucleus but chromosomes separate after division

- Visible during prophase (of mitosis) and interphase
- Size in *drosophila* : 1000 DNA molecules long

HOW DO THEY LOOK LIKE?

- Series of dark bands (chromomere) alternate with interbands (where DNA is loosely coiled)
- Crossbanding pattern

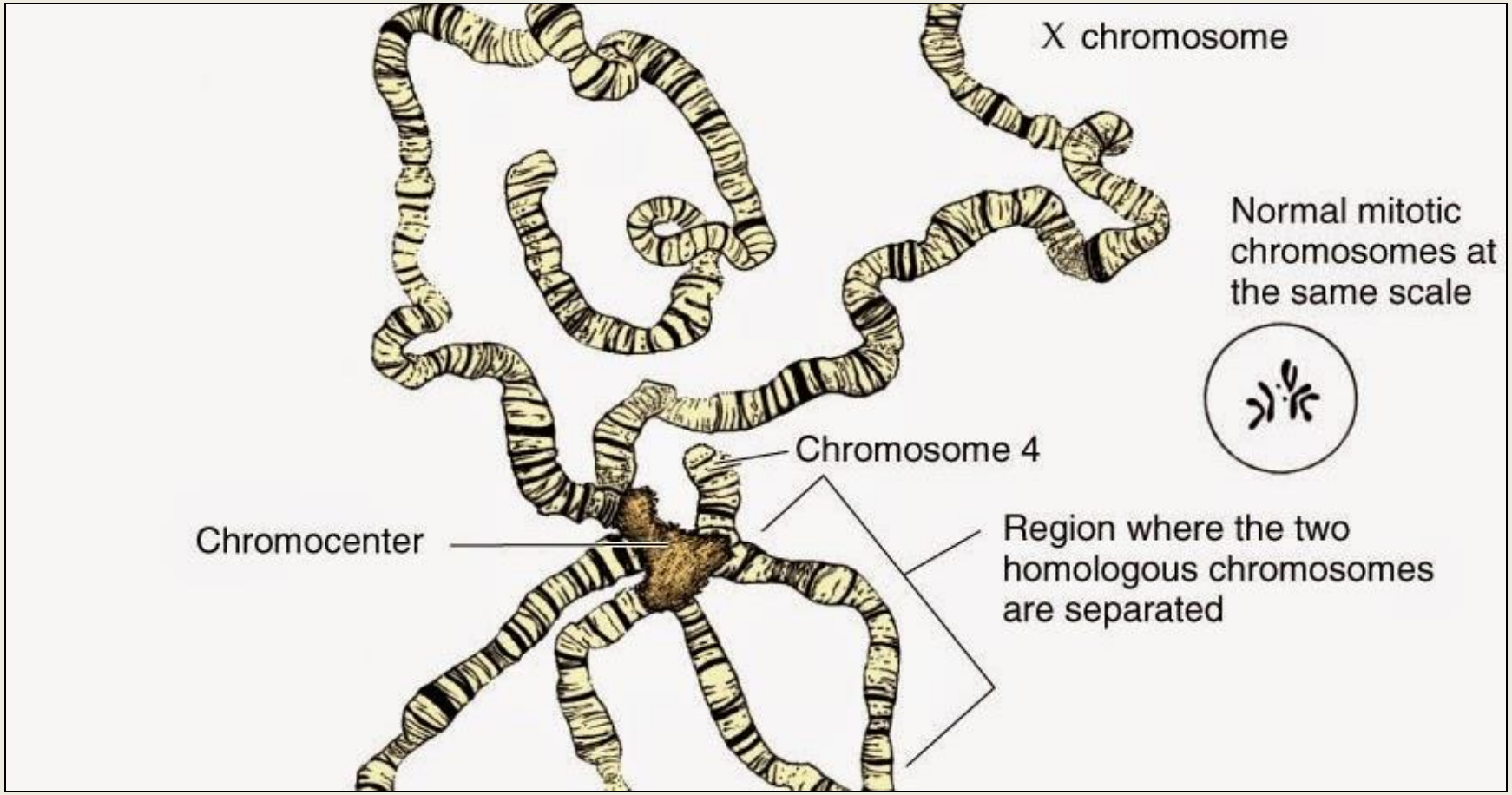


- Peculiar characteristic: maternal and paternal homologous chromosomes lie side by side → Somatic pairing
- In *drosophila*, heterochromatin of all polytene chromosomes--- coalesce--- chromocentre

CHROMOSOMAL PUFFS/ BALBIANI RINGS

- Swellings of bands of polytene chromosomes
- Intense gene transcription area
- DNA unfolds --- open loops
- Distribution differ from one tissue to another
- Reversible phenomenon

Comparison


X chromosome
Normal mitotic chromosomes at the same scale
Chromosome 4
Chromocenter
Region where the two homologous chromosomes are separated

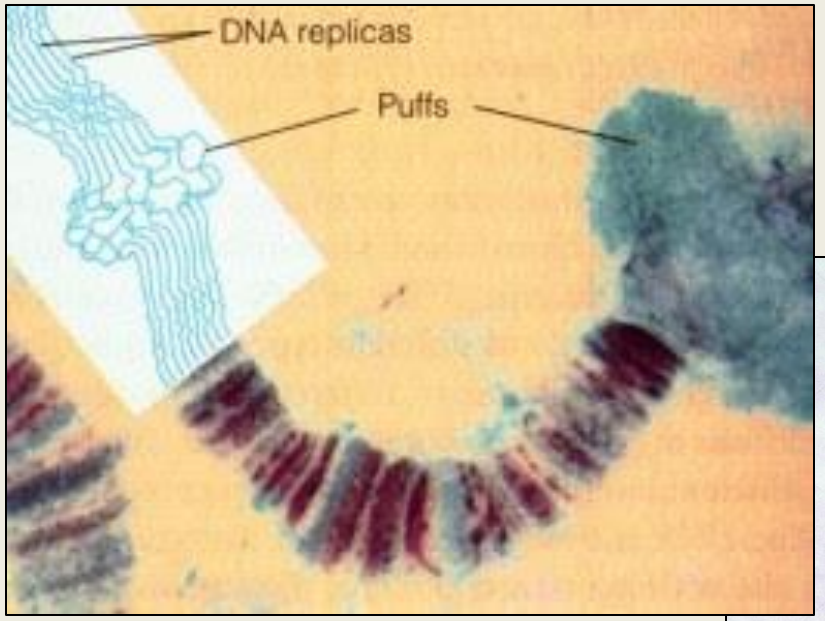
Why are they formed? (functions)

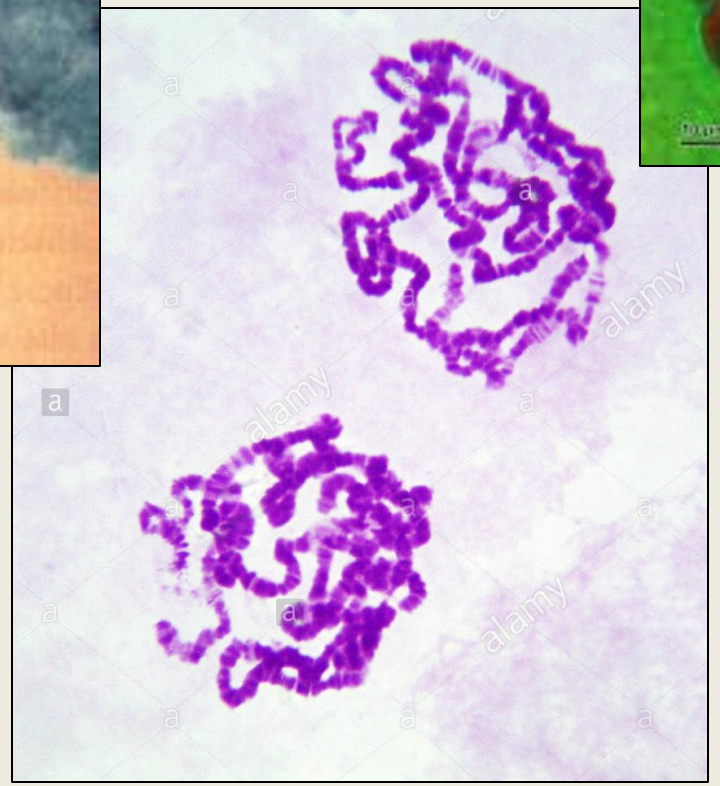
- Possible explanation by Alberts *et all*
- Mainly three reasons:

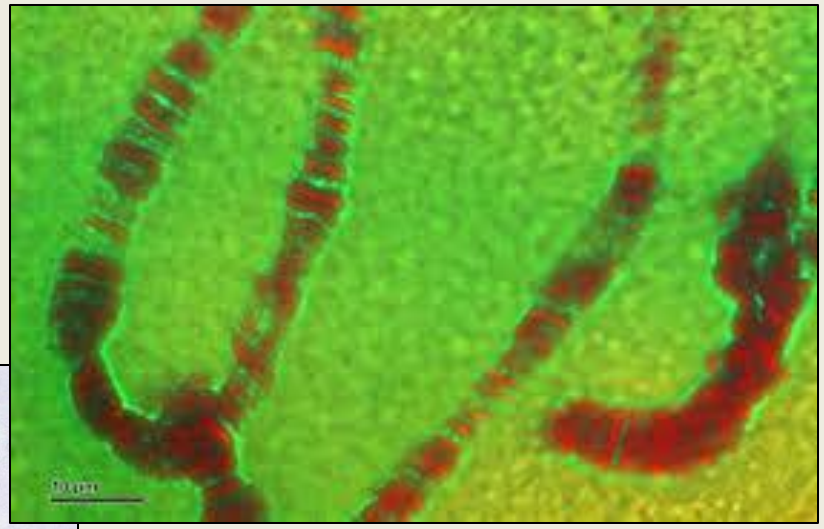
1. To keep DNA organised
2. Isolate genes from their neighbours
3. Regulate gene transcription for cell differentiation

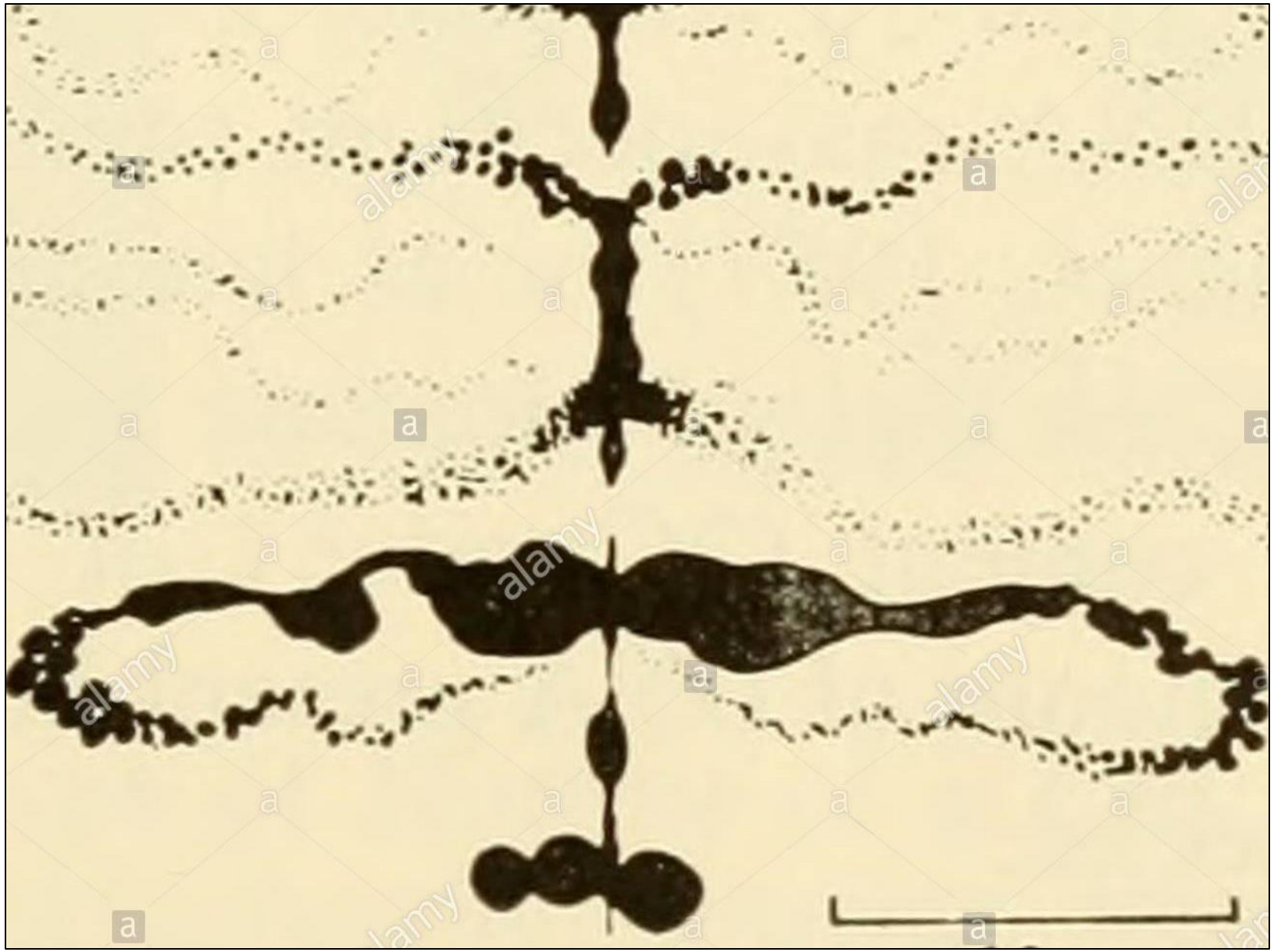
- Interbands: housekeeping genes
- Bands: cell-type specific genes

Under microscope









LAMPBRUSH CHROMOSOMES

Introduction

- 1st observed in salamander oocytes
- Name--- looks like brushes used to clean old kerosene lamps
- Described in detail in shark oocytes
- Occurs at diplotene stage of prophase (meiosis I) (extended diplotene stage)
- Much larger/ longer than polytene chromosomes
- most conspicuous feature is widespread RNA transcription
- Not formed in mammals

How are they formed?

- Formed during an extended diplotene stage of 1st meiotic division of female gametocyte
- The chromosomes go from a compact telophase form at the end of the last oogonial mitosis, become "lampbrushy"
- Then contract again to form normal first meiotic metaphase bivalents

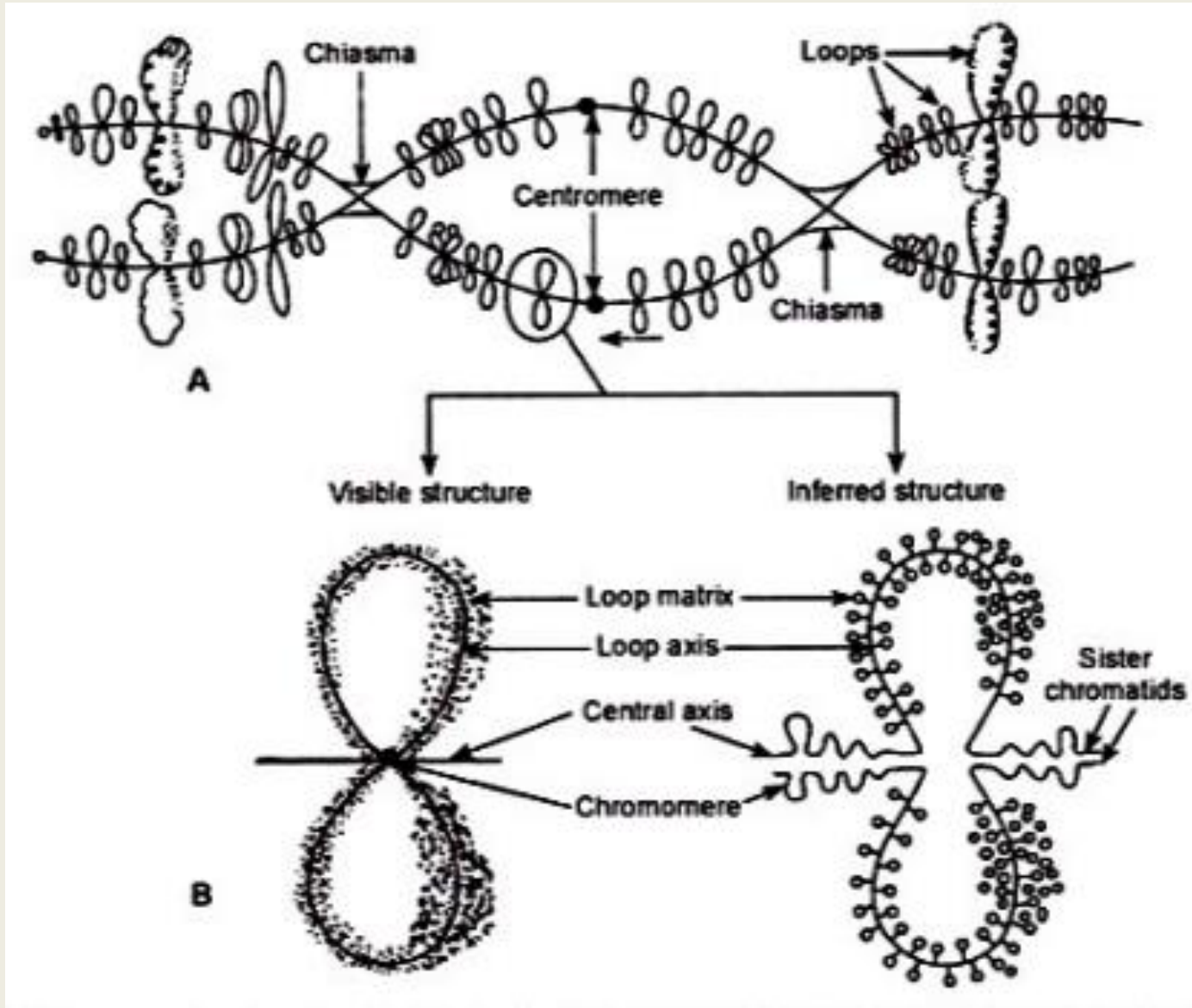
Leptotene→ zygotene→ pachytene→ **Diplotene**

How do they look?

- Brush like (RNA polymerase + nascent RNA + proteins)
- Bivalent (2 homologous chromosomes) held together by chiasmata
- Length can be up to 1mm

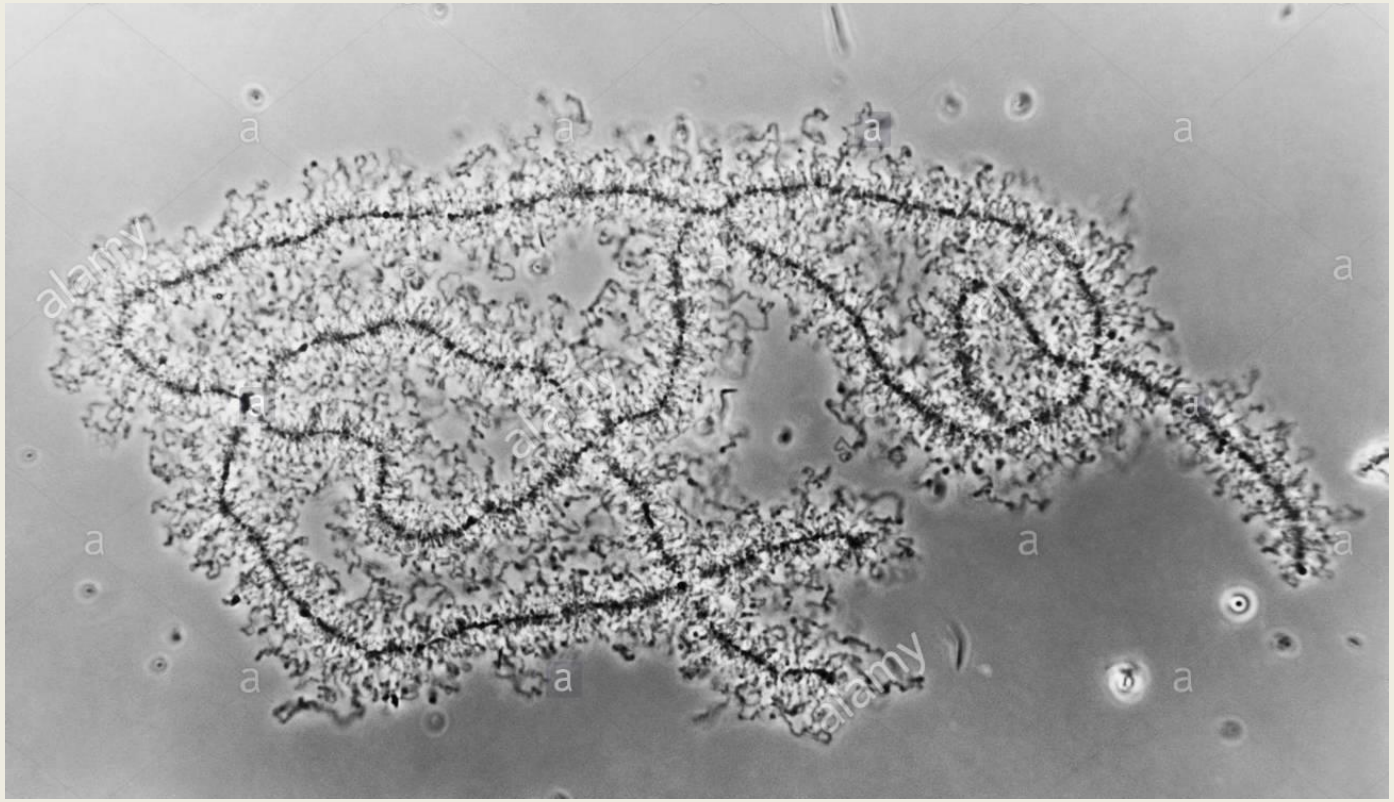
LOOPS:

- Always symmetrical
- Not formed at centromere
- About 10,000 loops in each chromosome set
- Each loop has an axis (made of DNA → RNA polymerase present here)


Chiasma
Loops
Centromere
Chiasma
A
Visible structure
Inferred structure
Loop matrix
Loop axis
Central axis
Chromomere
Sister chromatids
B

FUNCTION OF THE LOOPS

- Each loop = intense transcription or hn RNA (heterogenous nuclear RNA)
- Proteins attached to RNA → ultimately released as ribonucleoproteins
- Loops may be static or dynamic (spinning out and retraction hypothesis) → rejected



Hypothesis regarding loops of lampbrush chromosomes

1. Spinning out and retraction hypothesis (Gall and Callan)

In this, new material "spin out" of one side of the chromosome forming a loop and retract on the other side.

Meaning all genome can be expressed

Rejected

2. Master and slave hypothesis (Callan and Lloyd)

One loop contain a number of copies of one gene out of which one is the master copy

Information is transferred from it to the 'slave' copies

Slave copies → transcribes to RNA

Many copies means higher rate of RNA synthesis is possible

Functions of lampbrush chromosome

- Involved in the production of mRNAs for early development
- Giant granular loops could either be the sites where such mRNAs are packaged
- Could be sites where specific alterations of the deoxyribonucleoprotein fiber take place.
- Gene amplification→ required during growth phase of oocytes

THANK YOU