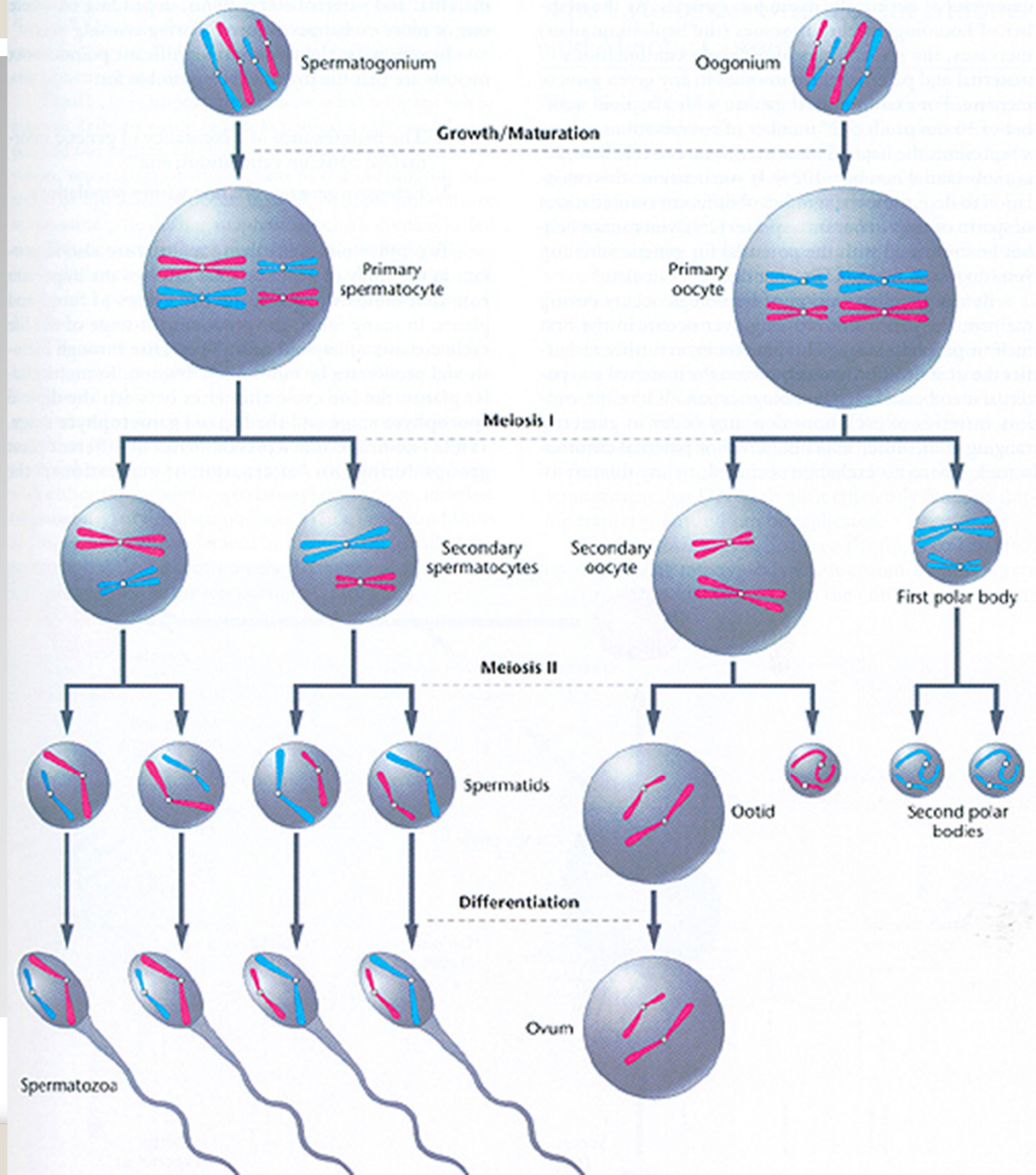


# **Genetic and Biotechnology in Aquaculture**

## Gametogenesis

- **Gametogenesis** is the creation of gametes.
- In males, it is **spermatogenesis**, creation of sperm.
- In females, it is **oogenesis**, creation of ova.



- Meiosis generates **genetic diversity** through:
  - the exchange of genetic material between homologous chromosomes during Meiosis I
  - the random alignment of maternal and paternal chromosomes in Meiosis I
  - the random alignment of the sister chromatids at Meiosis II

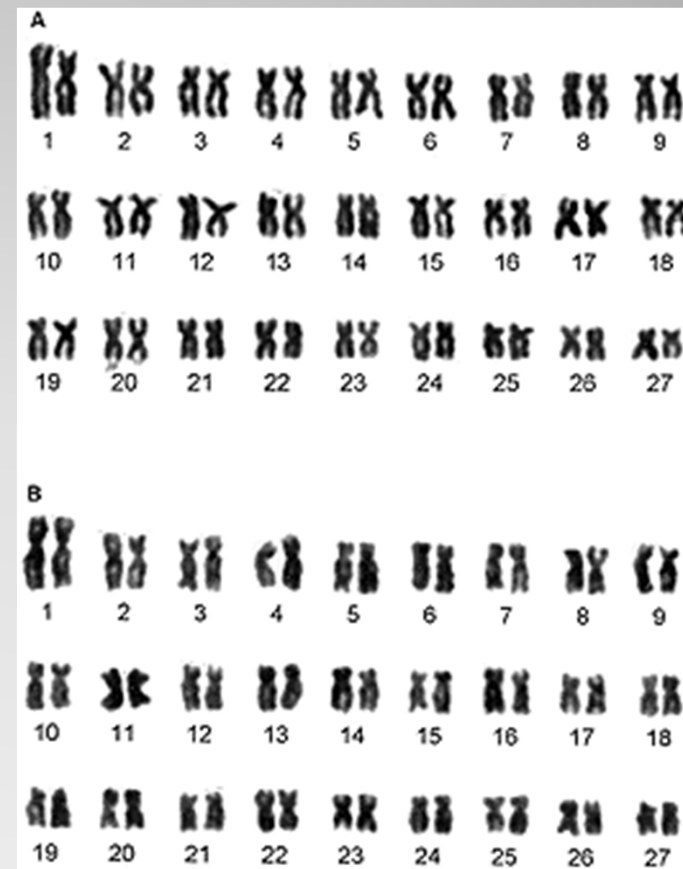
# Cytogenetic and Kariology

Cytogenetics: is a branch of genetics that is concerned with the study of the structure and function of the cell, especially the chromosomes.

An eukaryotic chromosome is a molecule of DNA together with associated proteins  
Carries part or all of a cell's genetic information

# Chromosome Number

- ◆ Most fish are diploid ( $2N$ )
- ◆ Normal for most vertebrates  $\sim 50$  chromosomes typical (range 16-446)
- ◆ Produce haploid ( $1N$ ) gametes



# Chromosome Number

- Normally, all the individuals of a **species have the same number** of chromosomes.
- Closely related species usually have similar chromosome numbers.
- Presence of a whole sets of chromosomes is called **euploidy**.
- It includes haploids, diploids, triploids, tetraploids etc.
- Gametes normally contain only one set of chromosome - this number is called **Haploid**
- Somatic cells usually contain two sets of chromosome - **2n : Diploid**

# Chromosome Number

$3n$  - triploid

$4n$  - tetraploid

The condition in which the chromosomes sets are present in a multiples of "n" is **Polyploidy**

When a change in the chromosome number does not involve entire sets of chromosomes, but only a few of the chromosomes - is

**Aneuploidy.**

- Monosomics ( $2n-1$ )
- Trisomics ( $2n+1$ )
- Nullisomics ( $2n-2$ )
- Tetrasomics ( $2n+2$ )

# Chromosome Number

- ◆ Constant chromosome number usually characteristic of a species
- ◆ Some species may display variation
- ◆ Rainbow trout - 58-64 chromosomes
- ◆ Variation results when chromosome arms rearrange





# Types of Chromosomes

- **Sex chromosomes**

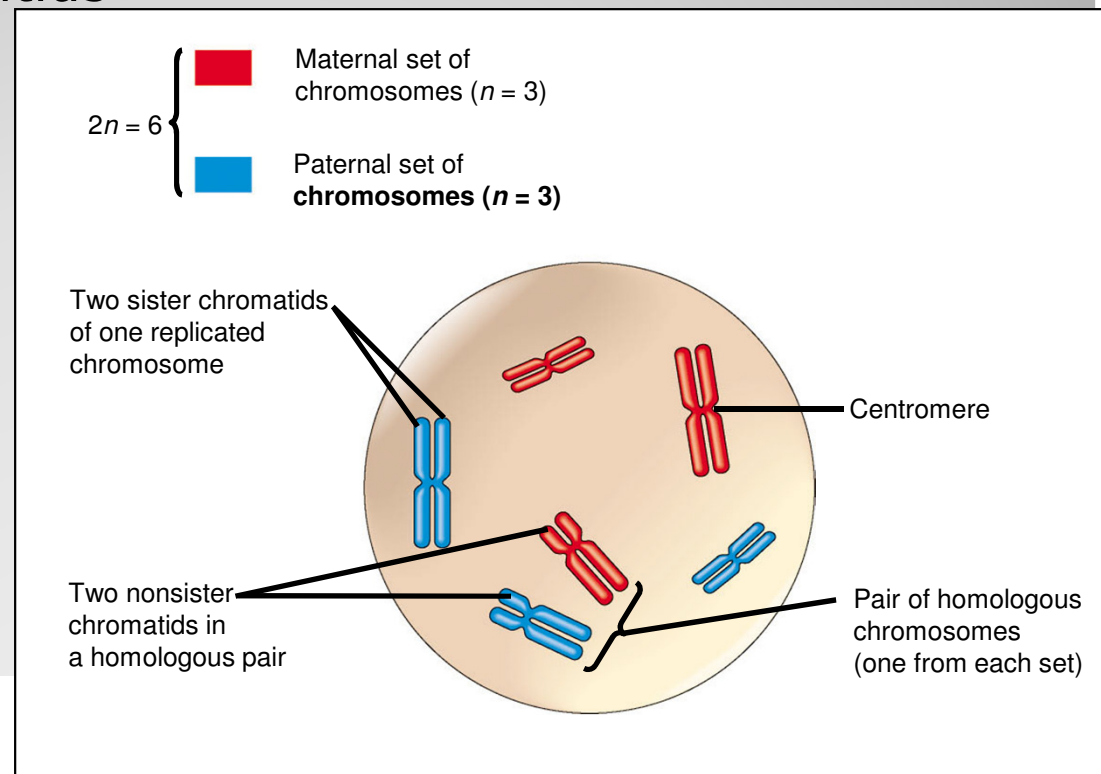
- In humans, the X and Y chromosomes that are involved in sex determination. These have different sizes and shapes

- **Autosomes**

- Chromosomes other than the sex chromosomes
- In trout, chromosomes 1 to 29 are autosomes

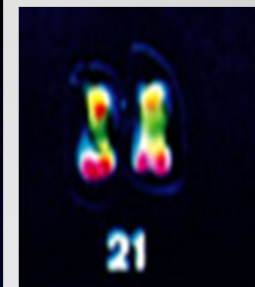
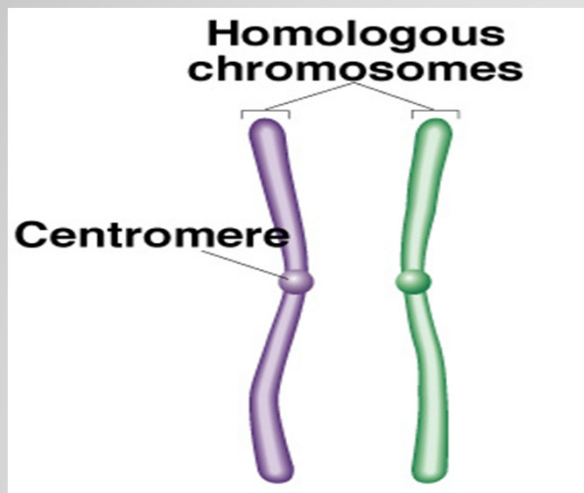
# Chromosomes

- A diploid cell has two sets of each of its chromosomes
- A trout has 60 chromosomes ( $2n = 60$ )
- In a cell in which DNA synthesis has occurred all the chromosomes are duplicated and thus each consists of two identical sister chromatids



# Homologues

- Homologous chromosomes:
  - Look the same
  - Control the same traits
  - May code for different forms of each trait
  - Independent origin - each one was inherited from a different parent

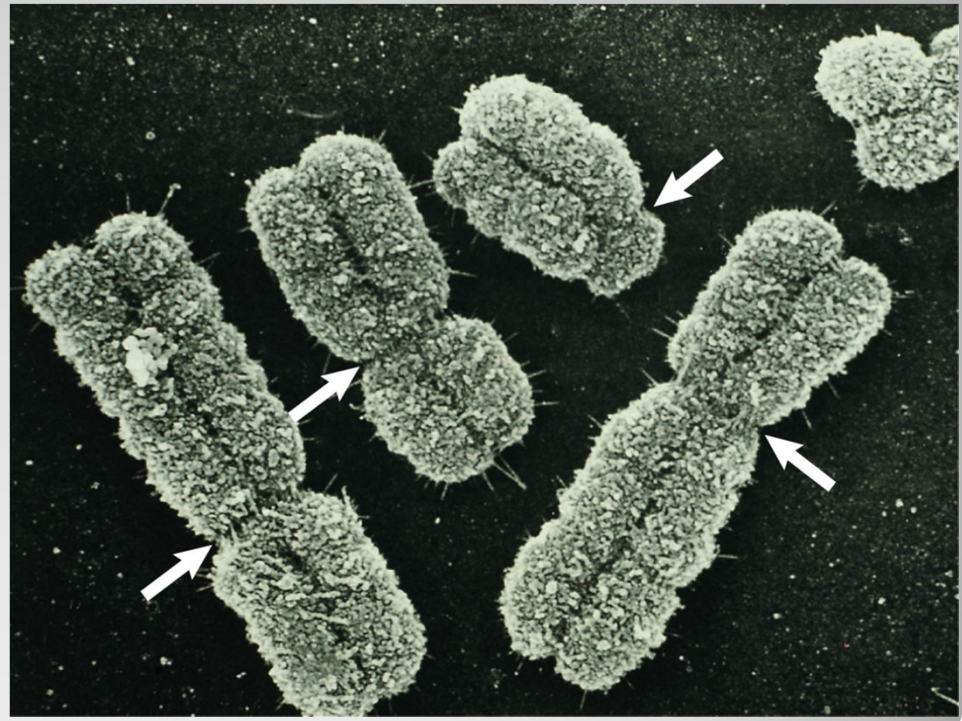
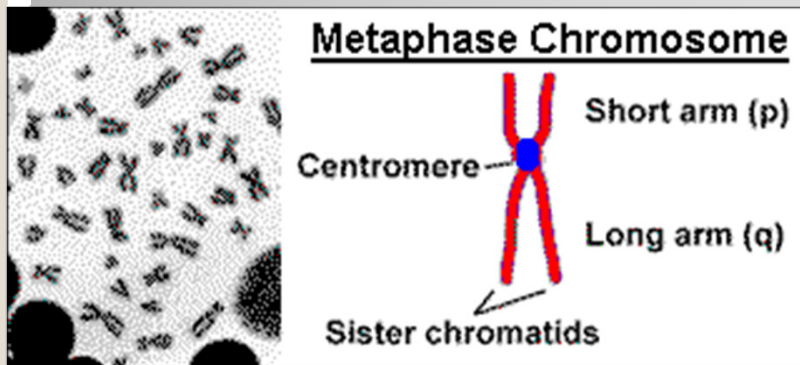


# Chromosome Shape

- As chromosomes condense and become visible during cell division, certain structural features can be recognized
- **1) Chromomere**
- **2) Centromere**
  - A region of a chromosome to which microtubule fibers attach during cell division
  - The location of a centromere gives a chromosome its characteristic shape

# Centromere Location

- Replicated chromosomes at metaphase consist of sister chromatids joined by a single centromere



- Chromosomes may differ in the position of the **Centromere**, the place on the chromosome where spindle fibers are attached during cell division.
- In general, if the centromere is near the middle, the chromosome is **metacentric**
- If the centromere is toward one end, the chromosome is **acrocentric** or **submetacentric**
- If the centromere is very near the end, the chromosome is **telocentric**.



Metacentric



Submetacentric



Acrocentric



Telocentric

Fig\_02-08 *Genetics, Second Edition* © 2005 W.H. Freeman and Company

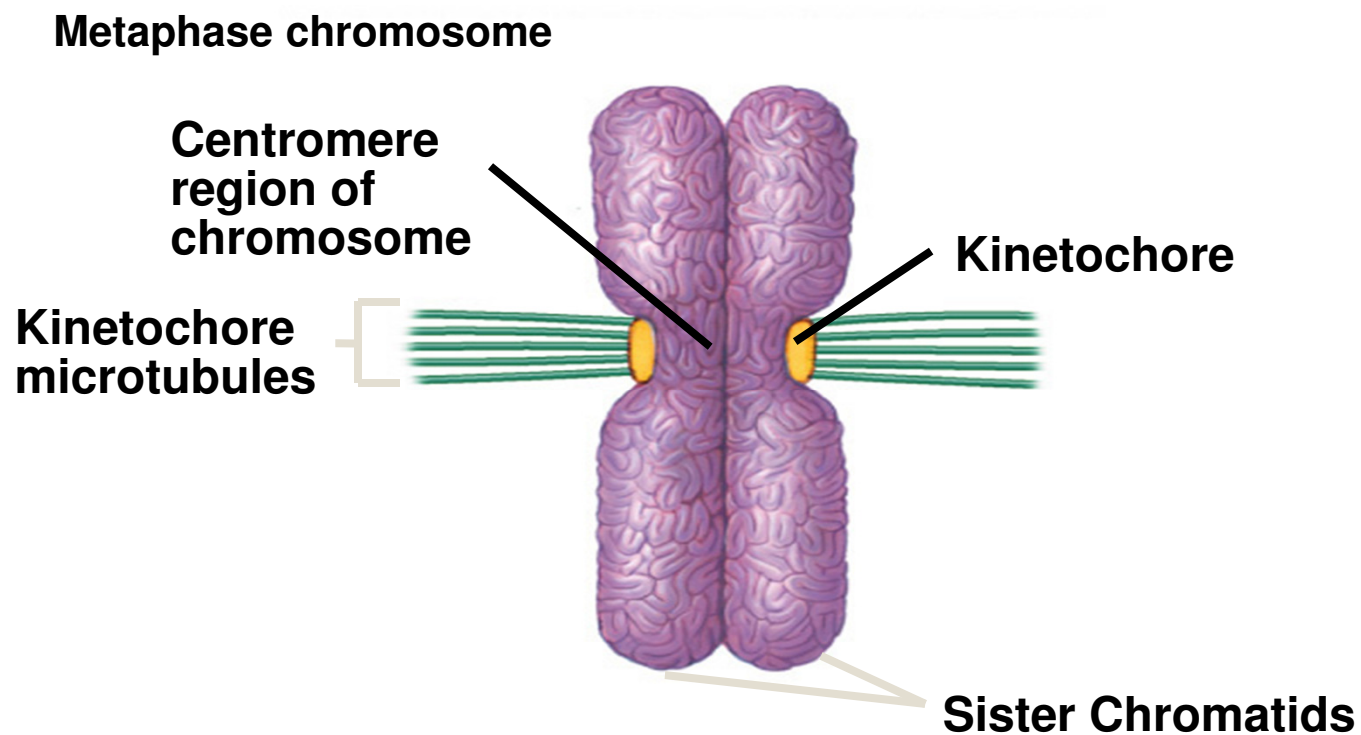
### 3) Kinetochore

- Within the centromere region, most species have several locations where spindle fibers attach, and these sites consist of DNA as well as protein.
- The actual location where the attachment occurs is called the **kinetochore** and is composed of both DNA and protein.
- The DNA sequence within these regions is called **CEN DNA**.



# Chromosome structure

- The centromere is a constricted region of the chromosome containing a specific DNA sequence, to which is bound 2 discs of protein called kinetochores.
- Kinetochores serve as points of attachment for microtubules that move the chromosomes during cell division:



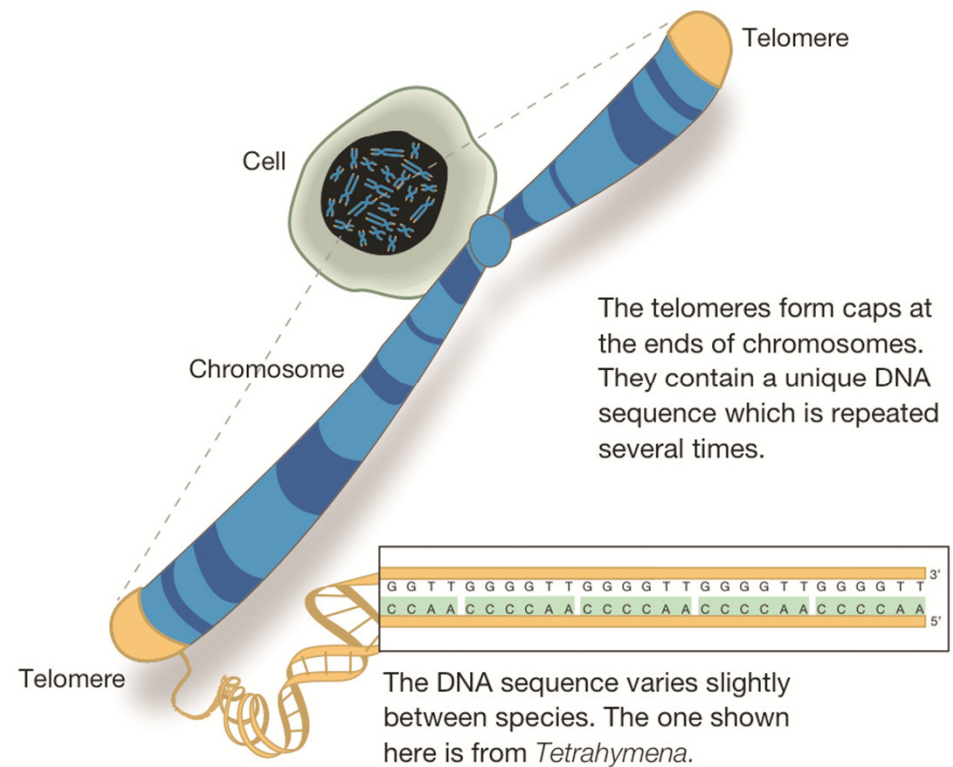
## 4) Telomere

- The two ends of a chromosome are known as telomeres.
- It required for the replication and stability of the chromosome.
- When telomeres are damaged or removed due to chromosome breakage, the damaged chromosome ends can readily fuse or unite with broken ends of other chromosome.
- Thus it is generally accepted that structural integrity and individuality of chromosomes is maintained due to telomeres.

- **Telomere Repeat Sequences**

until recently, little was known about molecular structure of telomeres. However, during the last few years, telomeres have been isolated and characterized from several sp.

- TTAGGG



- **5) Secondary constriction**; Besides the centromere, a **secondary constriction** can also be observed in some chromosomes which would pinch off a fragment called a
- **6) "satellite"**
- **7) Nucleolar organization**

