

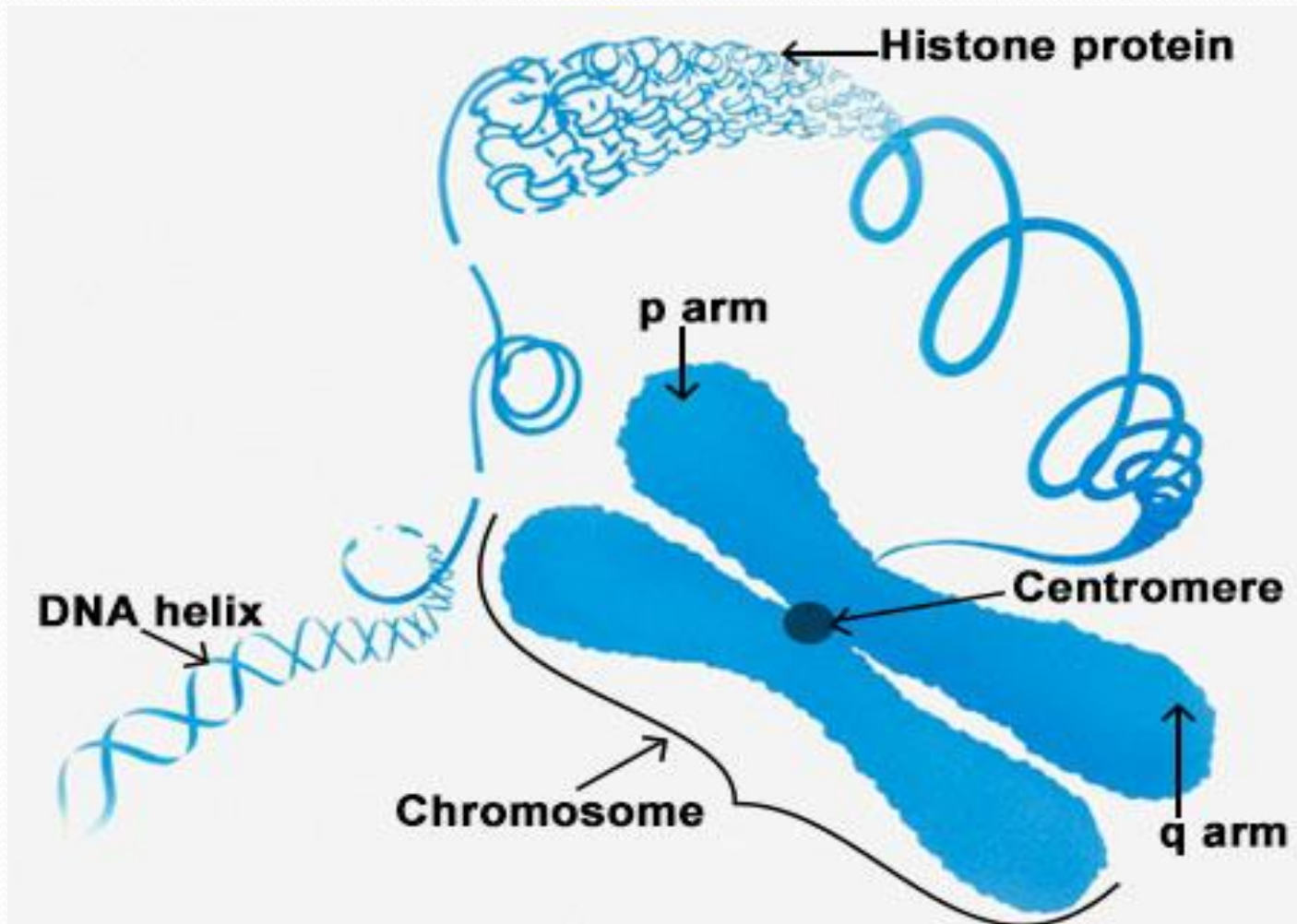
Zoo-352 Principles of genetics
Lecture 2

Chromosome

Chromosomes:

- Chromosomes were discovered by **Von Nageli** in 1842 after staining techniques were developed that made them visible.
- The term chromosome means the colored body.
- Linear eukaryotic chromosomes are composed of a complex of double-stranded DNA and protein, which is referred to collectively as **chromatin**.
- Chromatin can be found in either:
 1. a less condensed state **termed euchromatin** or
 2. a condensed and readily visible organization termed **heterochromatin**.

Structure of chromosome



Classification of chromosomes:

- Chromosomes are classified by the location of their spindle attachment point, which have distinct positions.
- The attachment point occurs at a construction in the chromosome termed the **centromere** (figure 1).
- Centromere is composed of several specific DNA sequences.
- The **kinetochore** is the proteinaceous structure on the surface of the centromere to which the spindle microtubules attach.
- The **centromere** and the **kinetochore** are structural units that are essential for mitosis and meiosis.
- Chromosomes can be classified according to the location of the centromere as bellow:
 - 1. Metacentric chromosome:** The centromere is in the middle of the chromosome (Figure 2).

2. Submetacentric chromosome: The centromere is located between the middle and the end of the chromosome (Figures 1 and 2).

3. Telocentric chromosome: The centromere is located at the end of the chromosome.

4. Acrocentric chromosome: The centromere is near to the end of the chromosome (Figure 2).

- The location of the centromere often divides the chromosome into two parts that are referred to as the short arm (**p arm** for petite) and the long arm (**q arm**).
- A **telomere** is a region of repetitive nucleotide sequences at each end of a chromatid, which protects the end of the chromosome from degradation or from fusion with neighboring chromosomes.

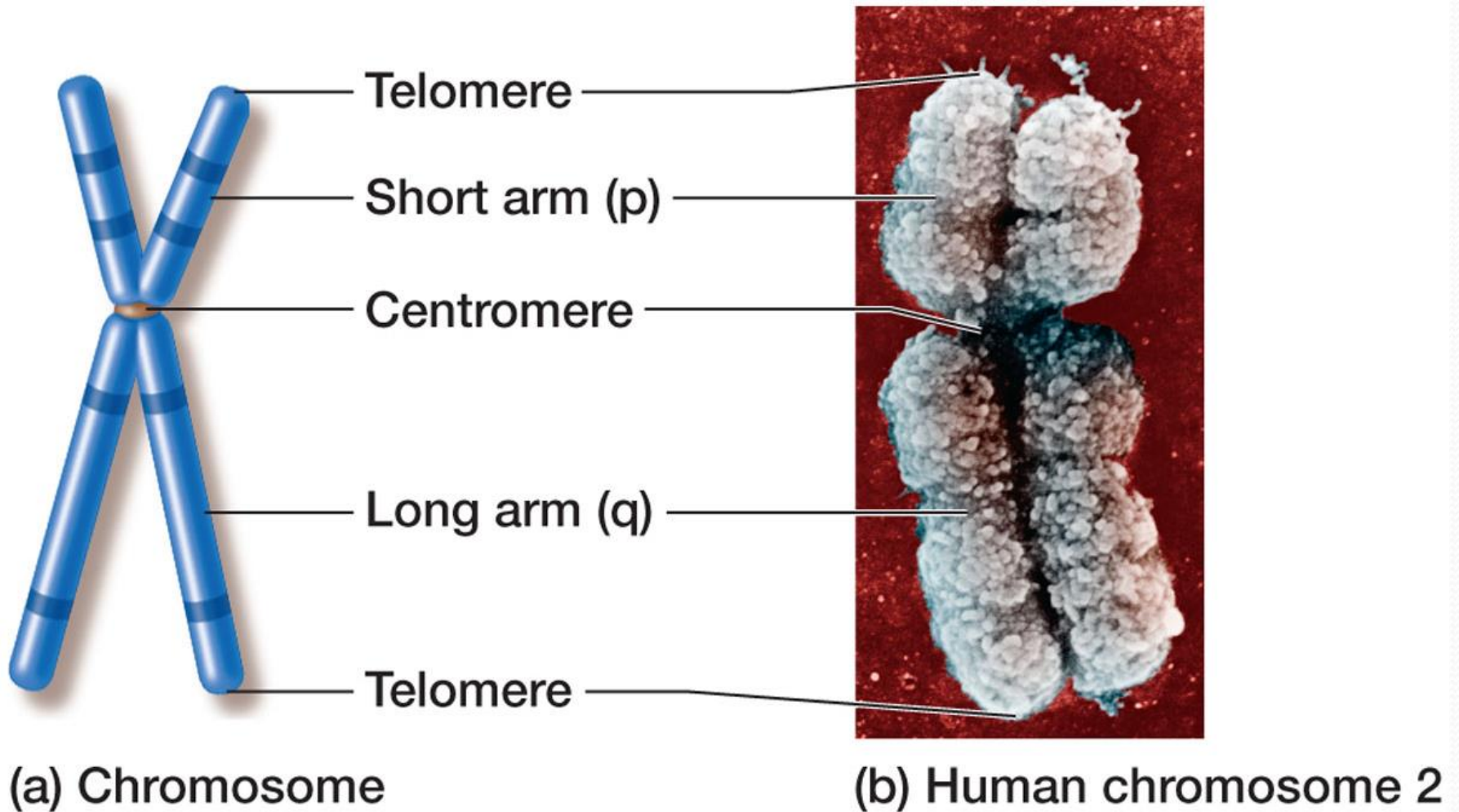


Figure 1: Schematic of Submetacentric chromosome (a) and an electron micrograph of human chromosome 2 (b).

Telomere



Light (G) bands

Less condensed chromatin (Euchromatin)



Centromere

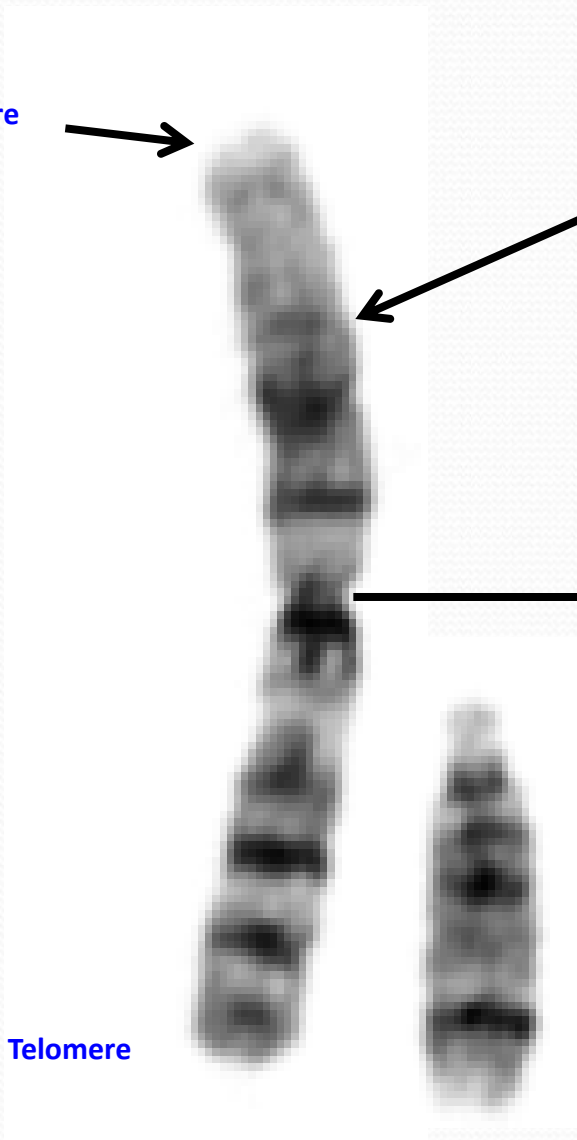
Joins two sister chromatids together



Telomere

Dark (G) bands

Contain condensed chromatin (Heterochromatin)



Classification of chromosomes

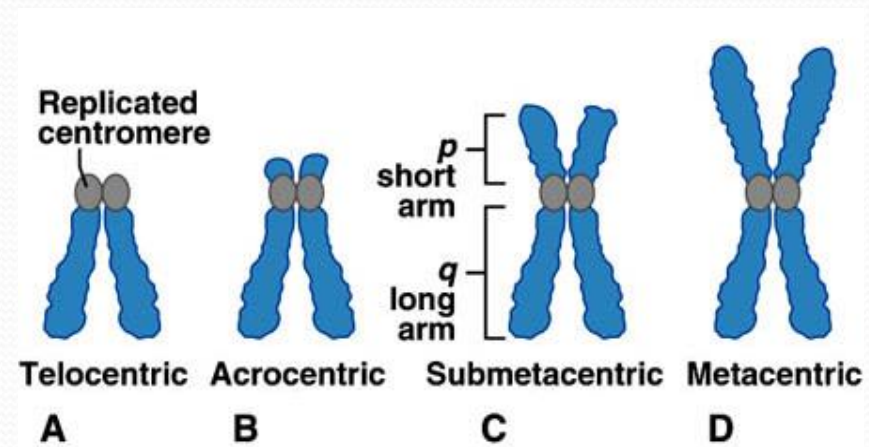
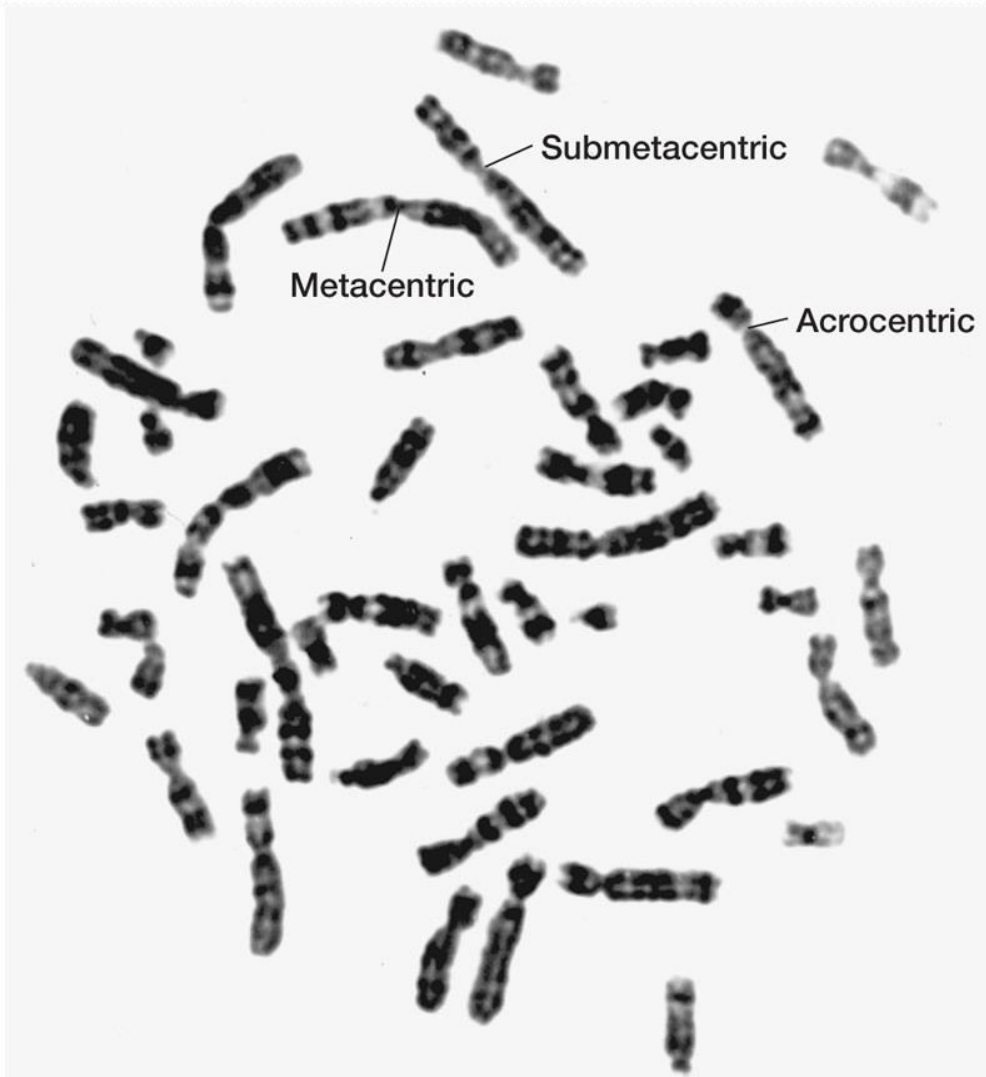


Figure 2: Metacentric, Submetacentric, and acrocentric chromosomes

Chromosome complement:

- Most cells of eukaryotic organisms are **diploid**; that contain two sets of chromosomes. In the diploid state, members of the same chromosome pair are referred to as **homologous chromosome**, or **homologs**. One member of each pair comes from each parent.
- Humans have 23 homologous chromosome pairs, which is often expressed as $2n=46$. This expression indicate that humans are diploid ($2n$) and have a total of 46 chromosomes. The diploid chromosome numbers of several species appear in table 1.
- **Haploid** cells, which include some eukaryotic organisms and the reproductive cells (gametes), have only one set of chromosomes.
- In humans, Chromosome pair 1-22 are called autosomes, determine body trait. The 23rd pair is called **sex chromosomes** (XX is female, XY is male), determine sex.
- Genes are arranged in the linear order on chromosome (Figure 3).

Species	2n
Human being (<i>Homo sapiens</i>)	46
Garden pea (<i>Pisum sativum</i>)	14
Fruit fly (<i>Drosophila melanogaster</i>)	8
House mouse (<i>Mus musculus</i>)	40
Roundworm (<i>Ascaris</i> sp.)	2
Pigeon (<i>Columba livia</i>)	80

Table 1: Chromosome number for selected species

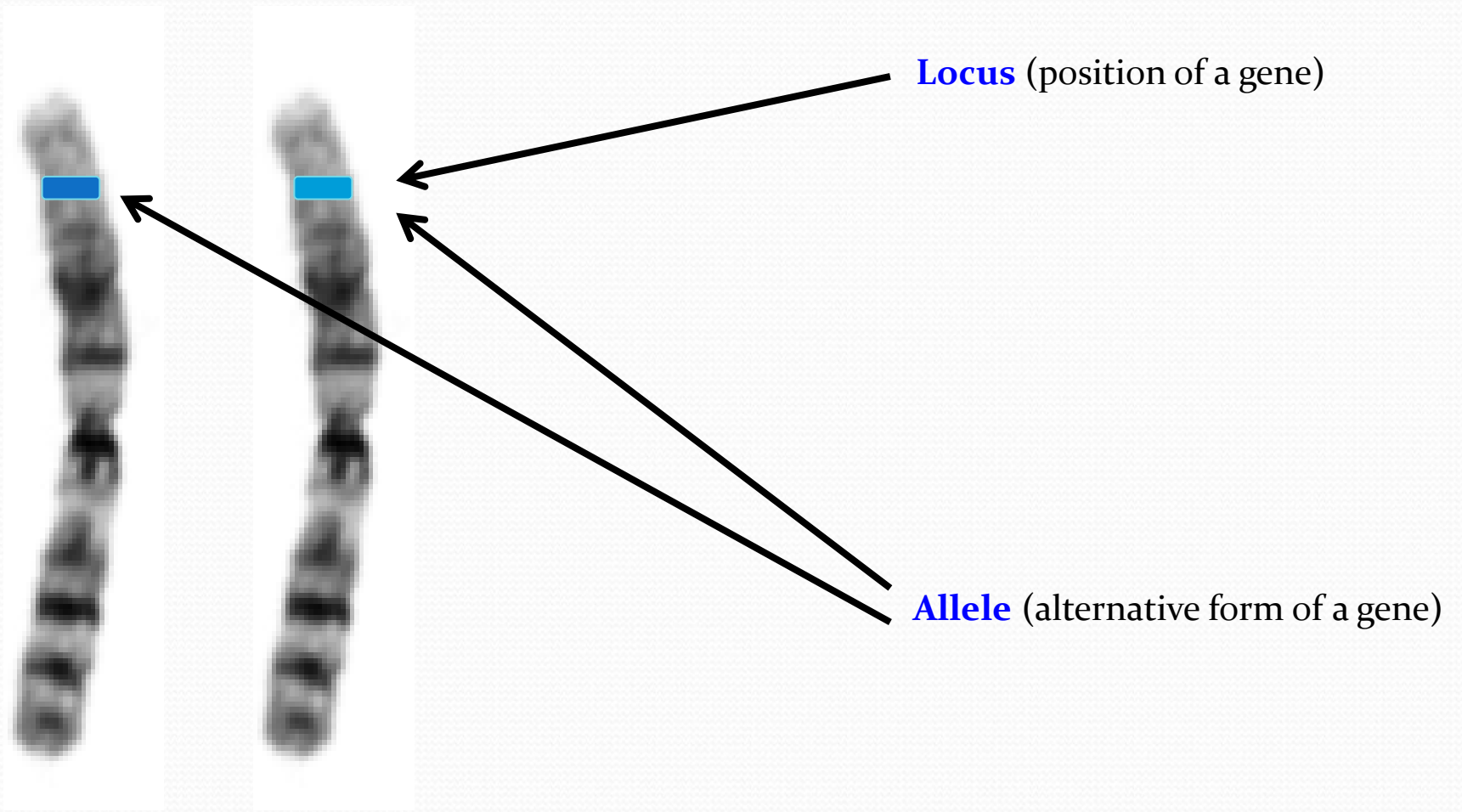
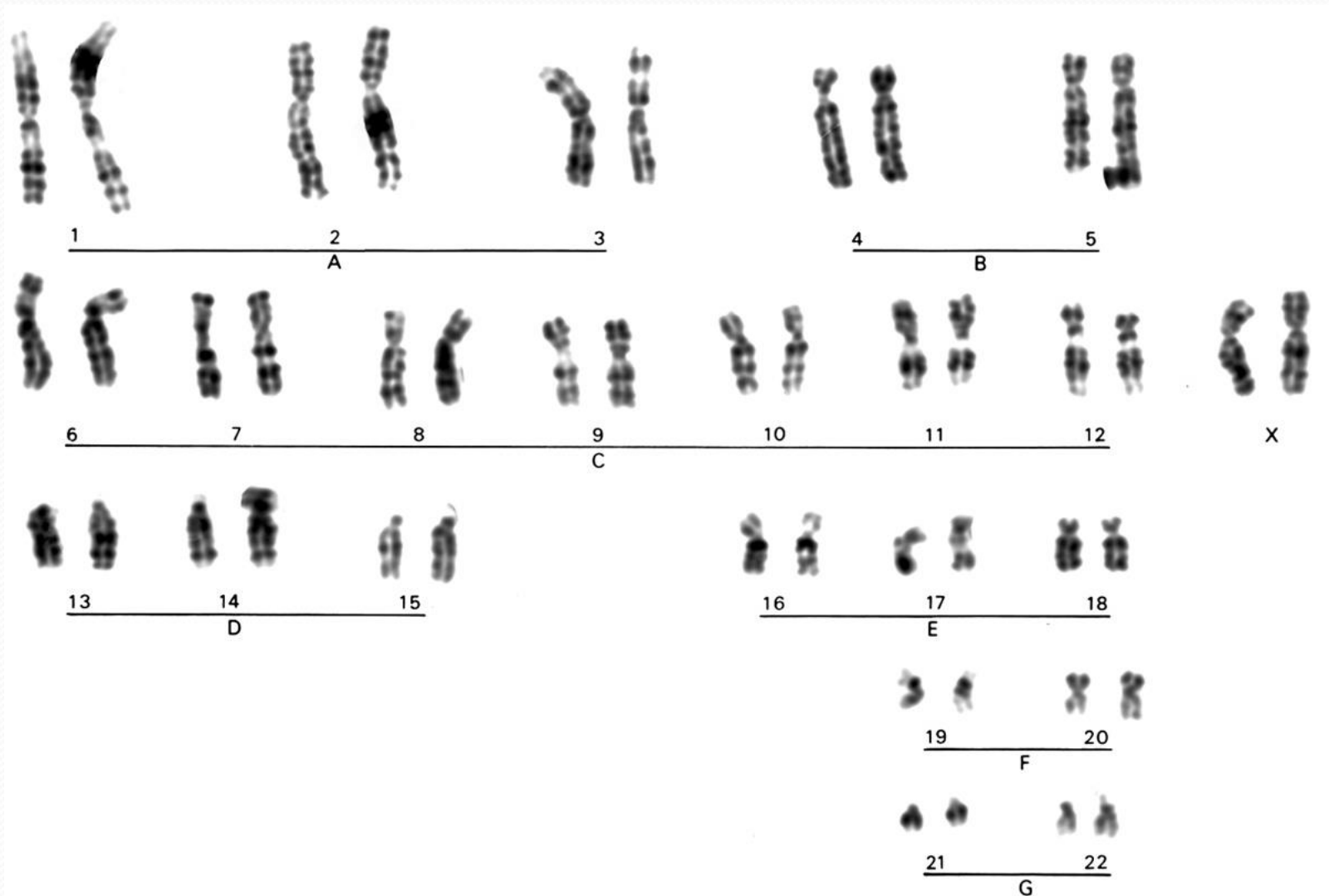


Figure 3: A pair of homologous chromosome 1 in humans

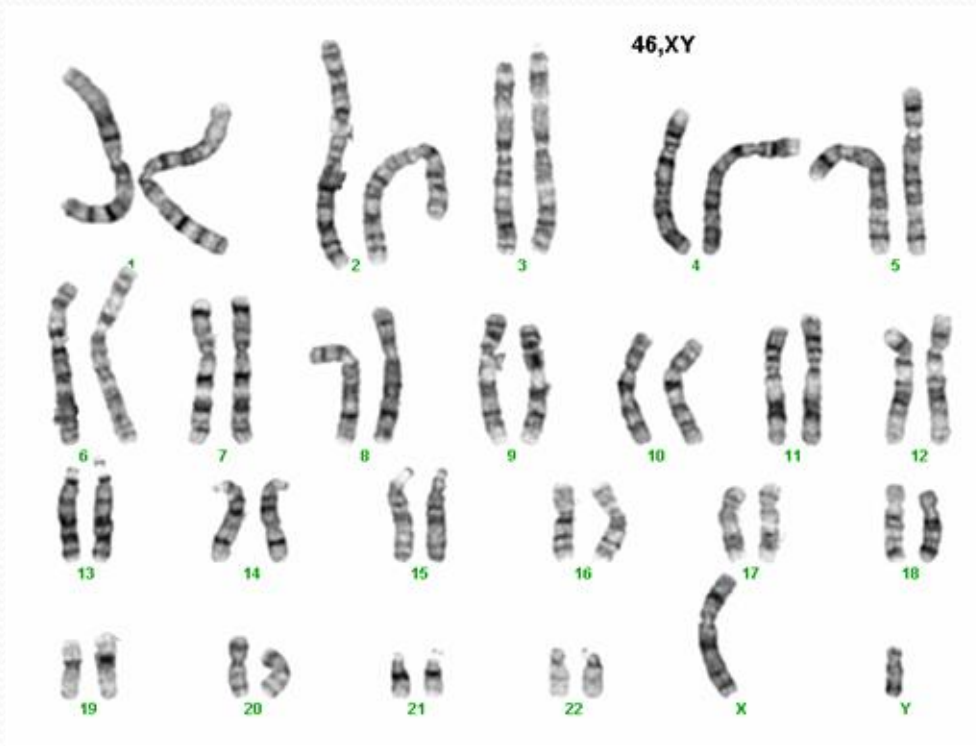
Karyotype of a human female



Karyotype:

- The total human's chromosomes can be photographed during mitosis and rearranged in pairs to make a picture called **a karyotype**.
- From karyotype, it is possible to see whether the chromosome have any **abnormalities** and to identify the **sex** of the individual.
- The chromosome in humans are grouped into categories (A-G, X, Y) based on **(1) their length (size), (2) centromere position** (location) and **(3) the pattern of dark and light G (Giemsa) bands** (Figure 4).

Karyotype of a human male



- Chromosomes are made of DNA and protein.
- Each contains genes in a linear order.
- Human body cells contain 46 chromosomes in 23 pairs – one of each pair inherited from each parent
- Chromosome pairs 1 – 22 are called **autosomes**.
- The 23rd pair are called **sex chromosomes**:
XX is female, XY is male.

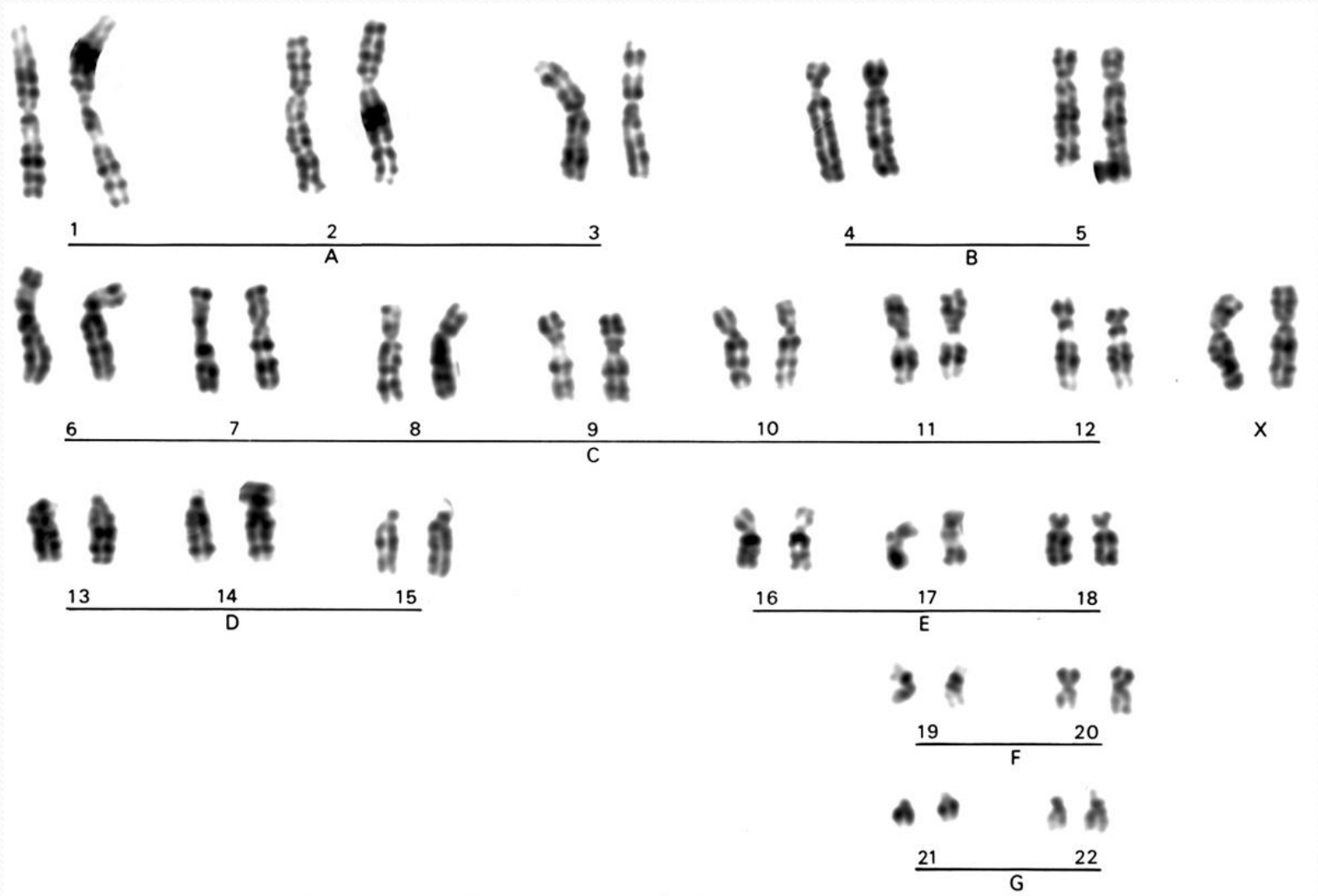


Figure 4: Karyotype of a human female (two X chromosomes, no Y chromosome)

Quiz - Chromosome Structure, Karyotypes

1. A human being has _____ autosomes and _____ sex chromosomes

- 23, 1
- 22 pairs, 1 pair
- 23, 23
- 2, 2

2. A section of chromosomes that codes for a trait can be called a(n):

- nucleotide
- base-pair
- gene
- nucleus

3. Somatic cells of a human have _____ chromosomes and are called _____

- 10, haploid
- 92, diploid
- 23, haploid
- 46, diploid

4. Each chromosome consists of two identical:

- genes
- nuclei
- chromatids
- bases