GENETICS

Biology

HEREDITY

- How characteristics are passed from one generation to another.

GREGOR MENDEL

- "Father of Genetics"
- Conducted the first important studies in genetics

GREGOR MENDEL

- Used pea plants because they were true breeding.
  - True breeding is when an organism is able to self-pollinate and offspring that are produce are identical to the parent.

- Cross pollinated the true breeding pea plants to study the results.

- Studied 7 traits

Table 14.1 The Results of Mendel's F_1 Crosses for Seven Characters in Pea Plants

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Character	Dominant Trait	×	Recessive Trait	F_2 Generation Dominant:Recessive	Ratio
Flower color	Purple	×	White	705:224	3.15:1
Flower position	Axial	×	Terminal	651:207	3.14:1
Seed color	Yellow	×	Green	6022:2001	3.01:1
Seed shape	Round	×	Wrinkled	5474:1850	2.96:1
Pod shape	Inflated	×	Constricted	882:299	2.95:1
Pod color	Green	×	Yellow	428:152	2.82:1
Stem length	Tall	×	Dwarf	787:277	2.84:1

Figure 14.x2 Round and wrinkled peas

Examples of Mendel's traits studied.

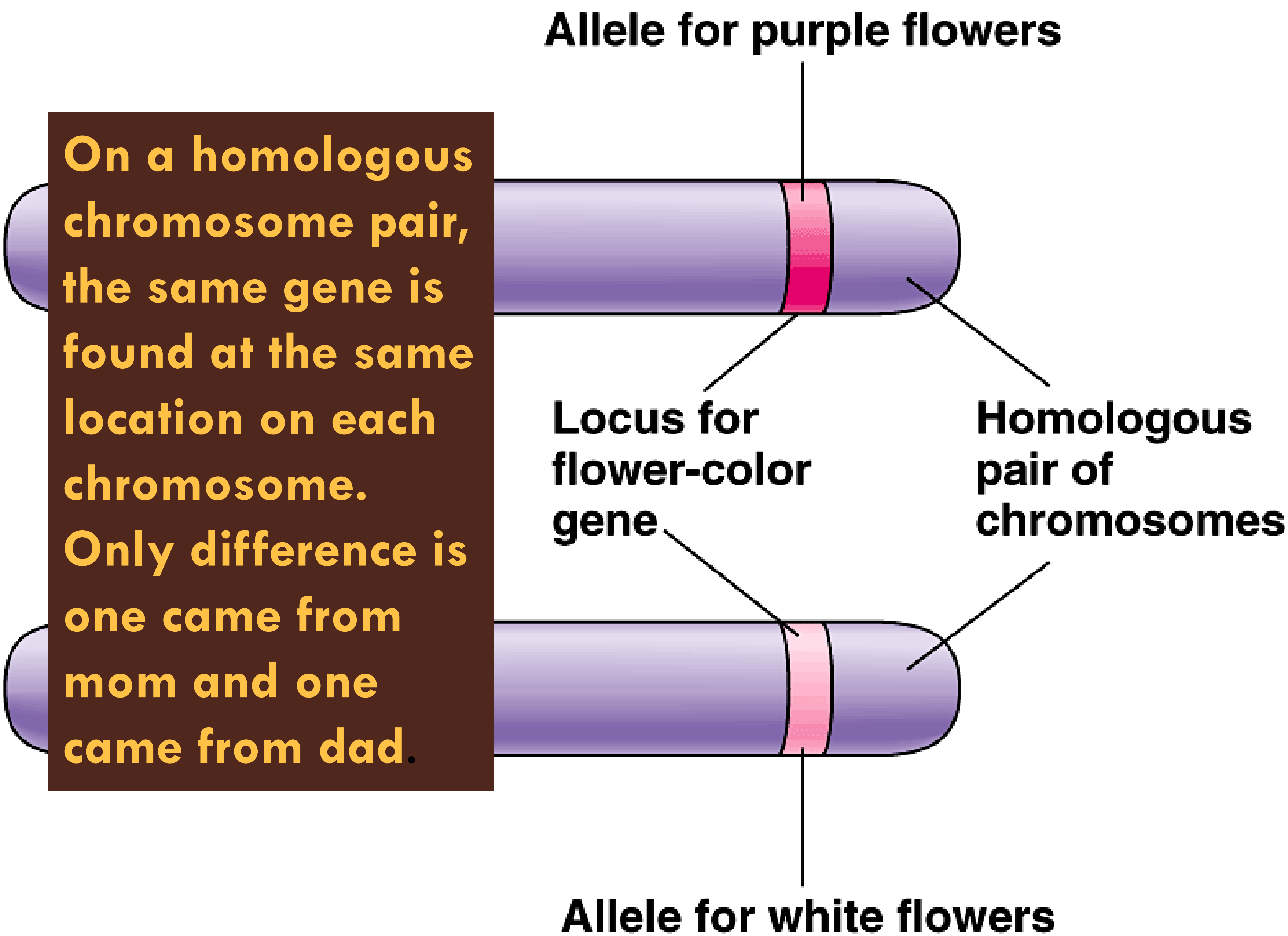
Smooth

TRAITS

- GENES: chemical factors that control each trait. They are located on chromosomes.
- ALLELES: different forms of the same gene
  - Example: eye color
  - Each organism has 2 alleles for each trait, one from the mother and one from the father.

Figure 14.3 Alleles, alternative versions of a gene

On a homologous chromosome pair, the same gene is found at the same location on each chromosome. Only difference is one came from mom and one came from dad.



HOMOZYGOUS VS HETEROZYGOUS TRAITS

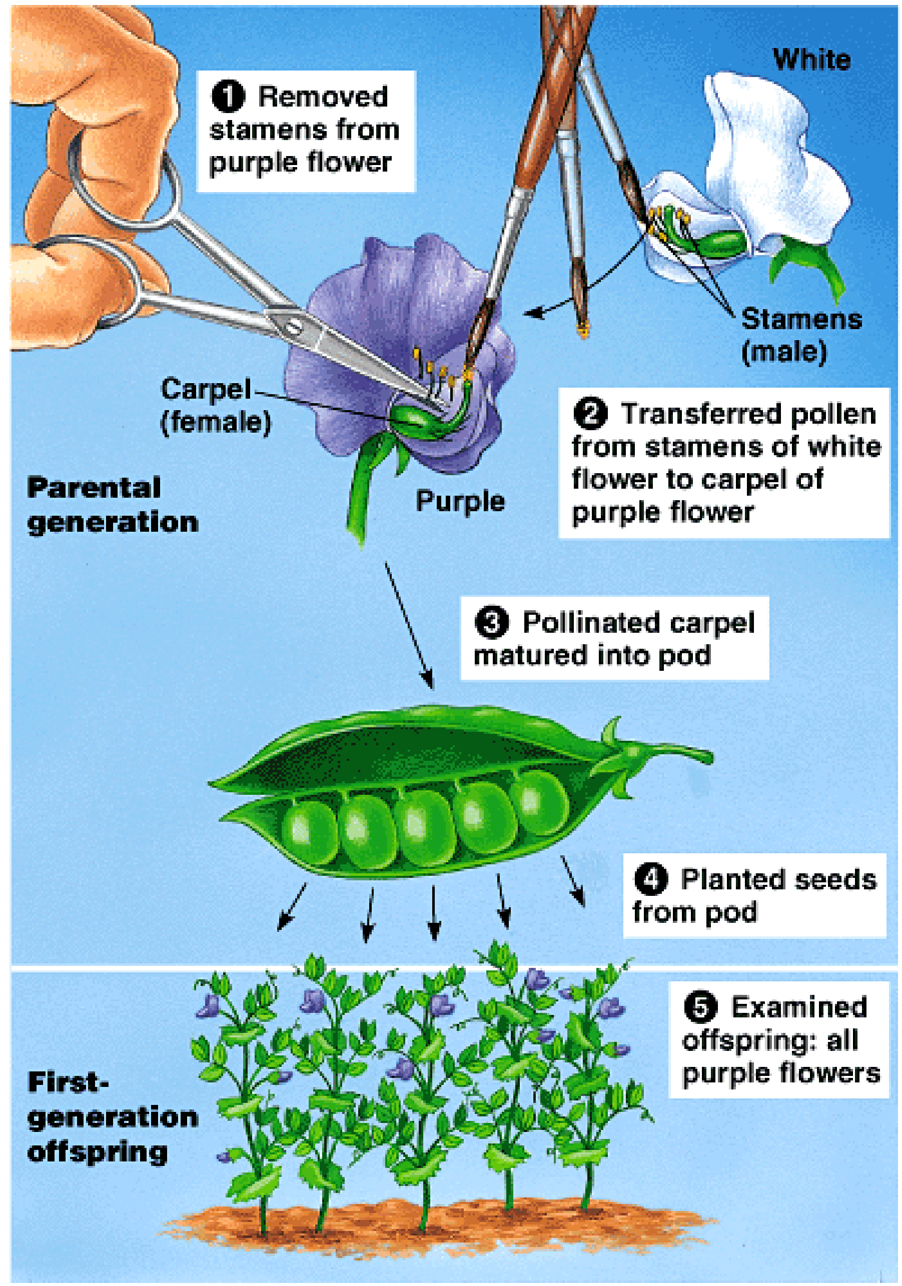
- HOMOZYGOUS (PURE OR TRUE BREED): an organism has two IDENTICAL alleles for a trait.
- HETEROZYGOUS (HYBRID): an organism has two different alleles for a trait. One is dominant and one is recessive

Figure 14.1 A genetic cross

Mendel's Experiment

CROSS BREEDING THE PEA PLANTS

HYBRIDS: THE OFFSPRING MADE FROM THE CROSSES OF PARENTS WITH DIFFERENT TRAITS (THE OPPOSITE OF TRUE BREEDS)



MENDEL'S LAWS

LAW OF <u>DOMINANCE</u>

- Some alleles are dominant and some are recessive
- <u>DOMINANT</u>: the observed trait (represented with a capital letter, example: B)
- <u>RECESSIVE</u>: the masked or hidden trait (represented with a lower case letter, example: b)

- RULES OF DOMINANCE:
  - If THE ORGANISM HAS…
    - 2 dominant alleles(BB), <u>DOMINANT</u> will be expressed.
    - 2 recessive alleles(bb), <u>RECESSIVE</u> will be expressed.
    - One dominant and one recessive(Bb), <u>DOMINANT</u> will be expressed

DIFFERENT FORMS OF A TRAIT

Purple= Dominant

White= Recessive

Figure 14.2 Mendel tracked heritable characters for three generations

PARENTAL GENERATION

FIRST GENERATION

(1ST OFFSPRING)

SECOND GENERATION

(2ND OFFSPRING)

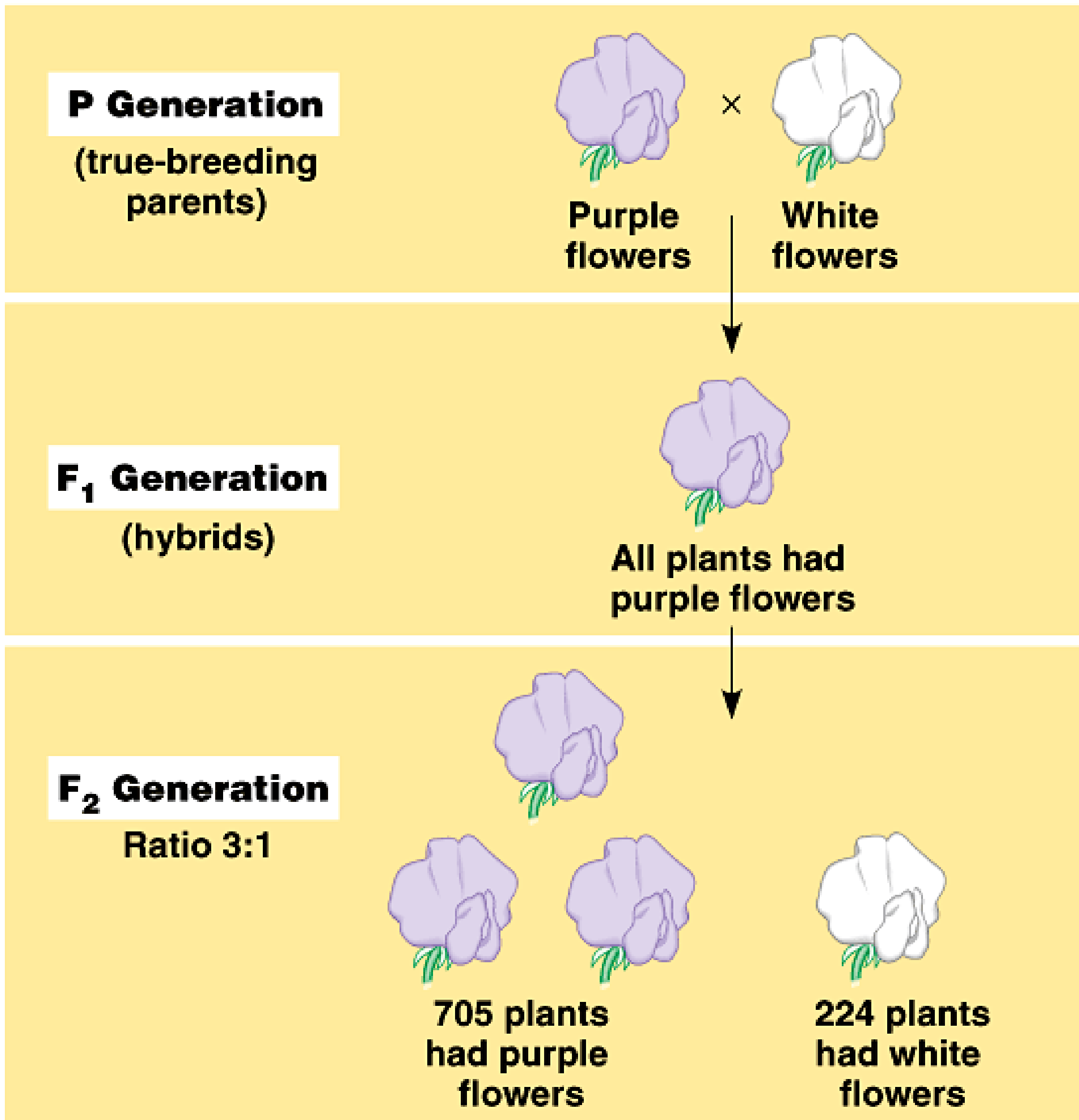
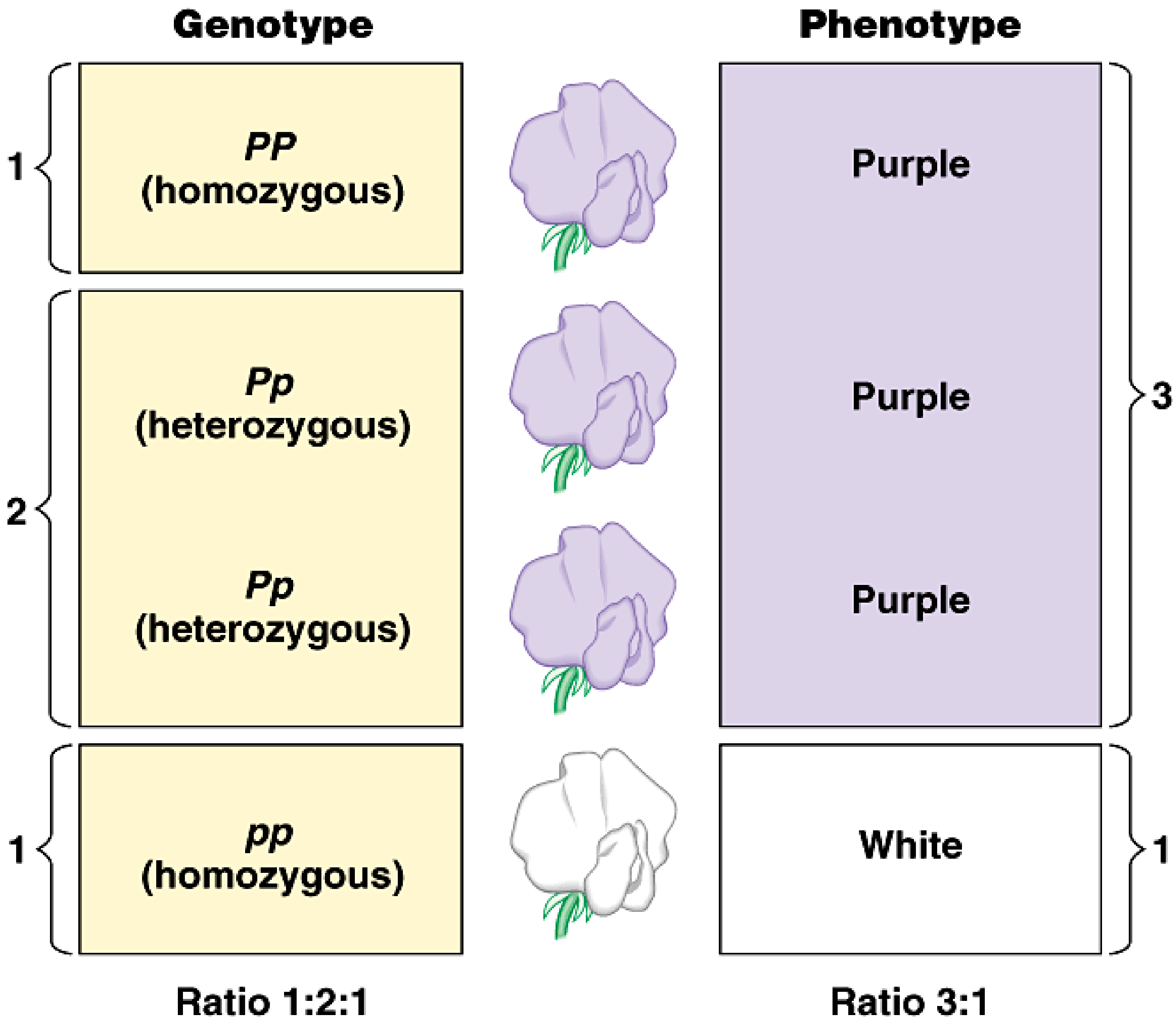


Figure 14.5 Genotype versus phenotype

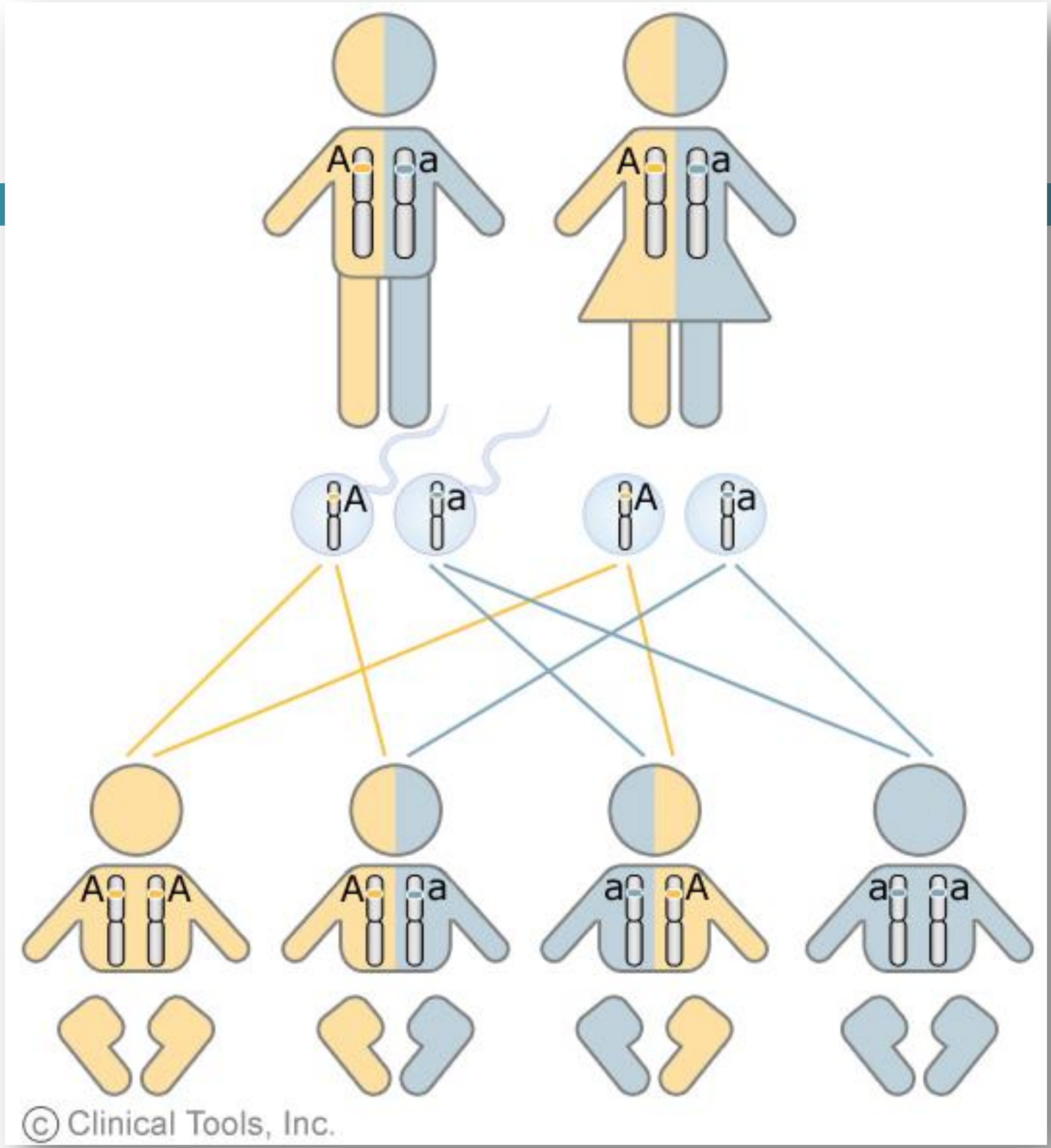


GENOTYPE VS. PHENOTYPE

- PHENOTYPE: the physically expressed trait.
- GENOTYPE: the actual gene combination (BB, bb, Bb)

LAW OF SEGREGATION

- An organism has 2 alleles for each trait.
- When the gametes or sex cells are produced, the alleles separate and each gamete will receive 1 allele.
- During fertilization (the meeting of egg and sperm, the gametes randomly pair to produce different combination of alleles.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LAW OF INDEPENDENT ASSORTMENT

- GENES FROM **DIFFERENT** TRAITS SPERATE **INDEPENDENTLY** FROM EACH OTHER.

- THEREFORE, ONE GENE WILL NOT **INFLUENCE** THE INHERITANCE OF ANOTHER GENE.

PUNNET SQUARES

PUNNET SQUARES & PROBIBILITY

- A PUNNET SQUARE IS A DIAGRAM THAT SHOWS ALL POSSIBLE GENE COMBINATIONS FROM GENETIC CROSSES.
- MONOHYBRID CROSS: THE CROSS OF ONE TRAIT.
- DIHYBRID CROSS: THE CROSS OF TWO TRAITS.
- THE PUNNET SQUARE WILL SHOW THE PROBABILITY OR THE LIKELYHOOD OF A COMIBINATION OF ALLELES FROM EACH PARENT.

EXCEPTIONS TO MENDEL'S LAWS

<u>INCOMPLETE DOMINANCE,</u>
CODOMINANCE, MULTIPLE ALLELES, & POLYGENIC TRAITS.

Figure 14.9 Incomplete dominance in snapdragon color

INCOMPLETE DOMINANCE

- Blending of 2 traits
- THE **HETEROZYGOUS** PHENOTYPE IS SOMEWHERE BETWEEN THE **TWO** HOMOZYGOUS PHENOTYPES.
- Example is the *Pink Snapdragon* flower

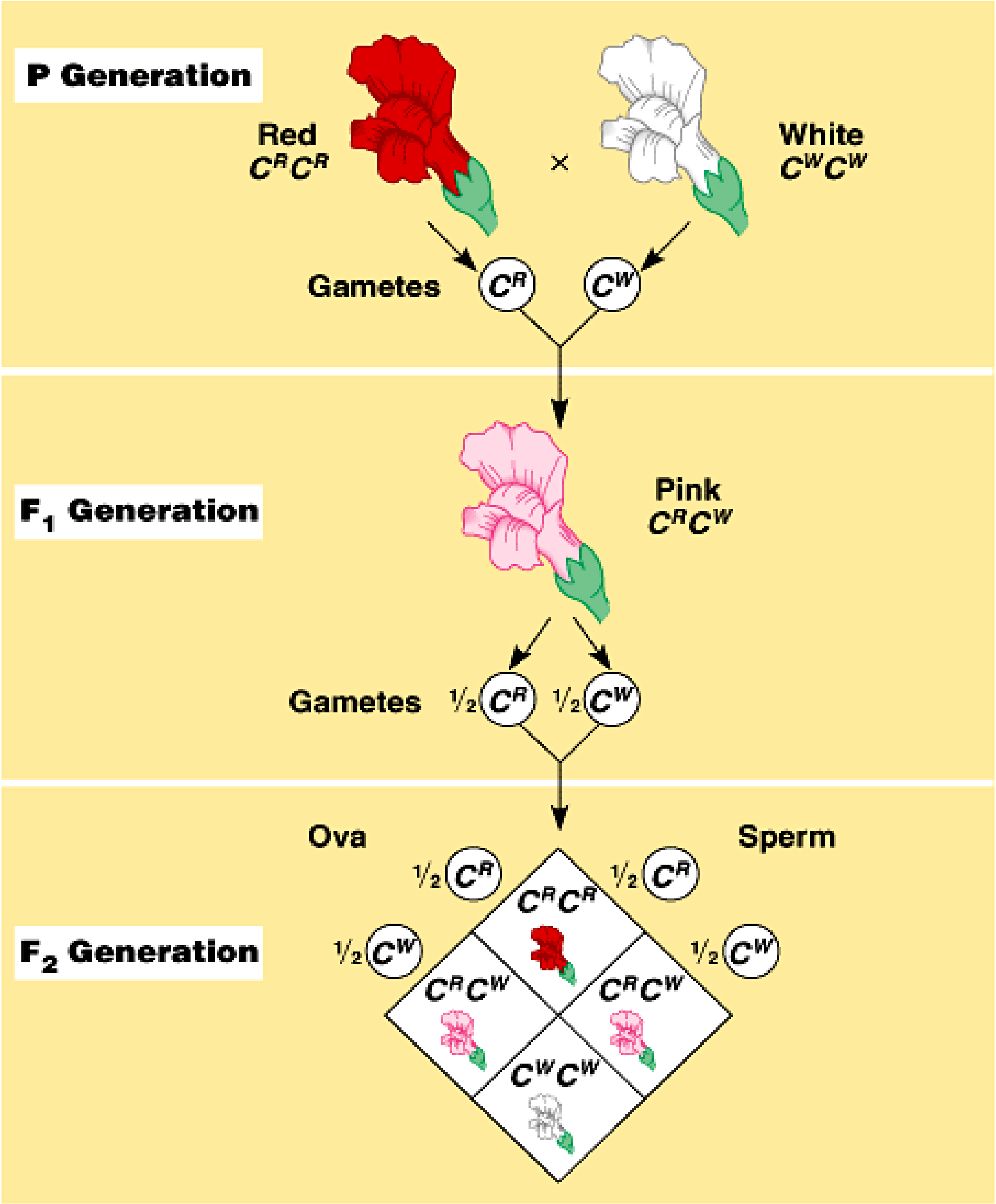
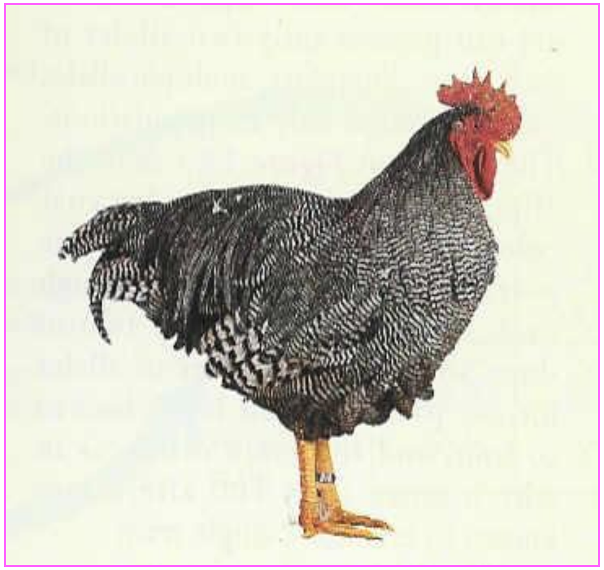


Figure 14.9x Incomplete dominance in carnations

Incomplete Dominance

CODOMINANCE

- BOTH ALLELES CONTRIBUTE TO THE PHENOTYPE
- BLACK FEATHER CHICKENS CROSS WITH WHITE FEATHER CHICKENS AND THE OFFSPRING HAVE BOTH BLACK AND WHITE FEATHERS



MULTIPLE ALLELES

- TRAITS HAVE MORE THAN 2 ALLELES IN A POPULATION.
- FOR EXAMPLE EYE COLOR…GREEN, BLUE, BROWN, HAZEL, ETC.

POLYGENIC TRAITS

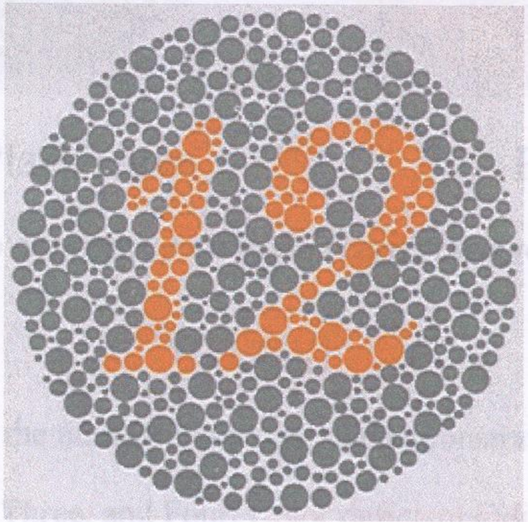
- TRAITS CONTROLLED BY 2 OR MORE DIFFERENT GENES.
- EXAMPLE: SKIN COLOR IS CONTROLED BY APPROXIMATELY MORE THAN 4 GENES

SEX-LINKED TRAITS

Sex-linked Traits

- There are <u>23</u> pairs of chromosomes in each human cell
- <u>22</u> of these pairs are **<u>autosomes</u>**
- 1 of these pairs are "<u>SEX CHROMOSOMES</u>"
  - Female looks like: <u>XX</u>
  - Male looks like: <u>XY</u>
    - Traits carried on this last pair (<u>23</u>) are called *<u>Sex linked traits</u>* (hemophilia, male pattern baldness, colorblindness)
    - Sex linked traits are usually located on <u>X</u> chromosome.

Color Blindness



Demonstration plate

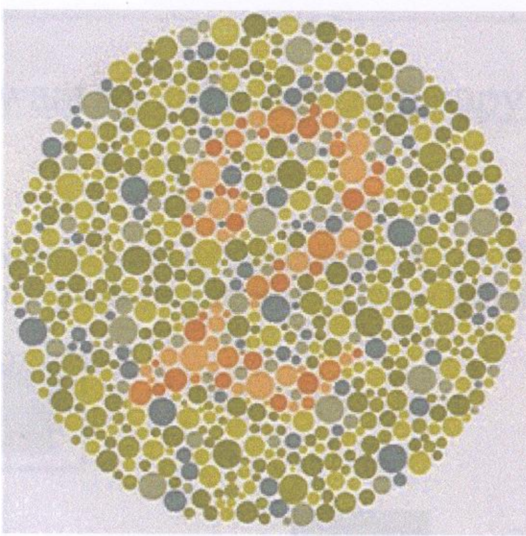


Plate One

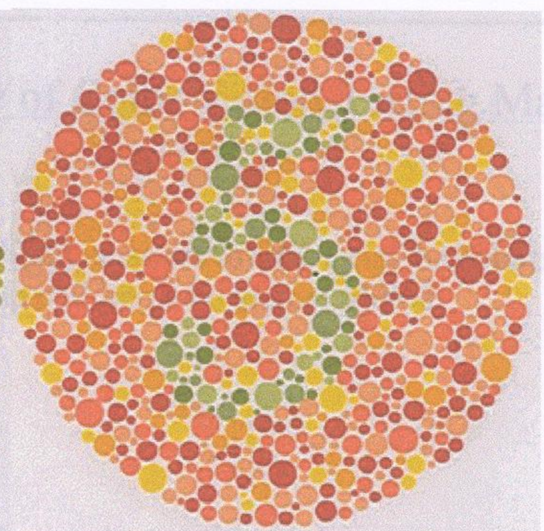
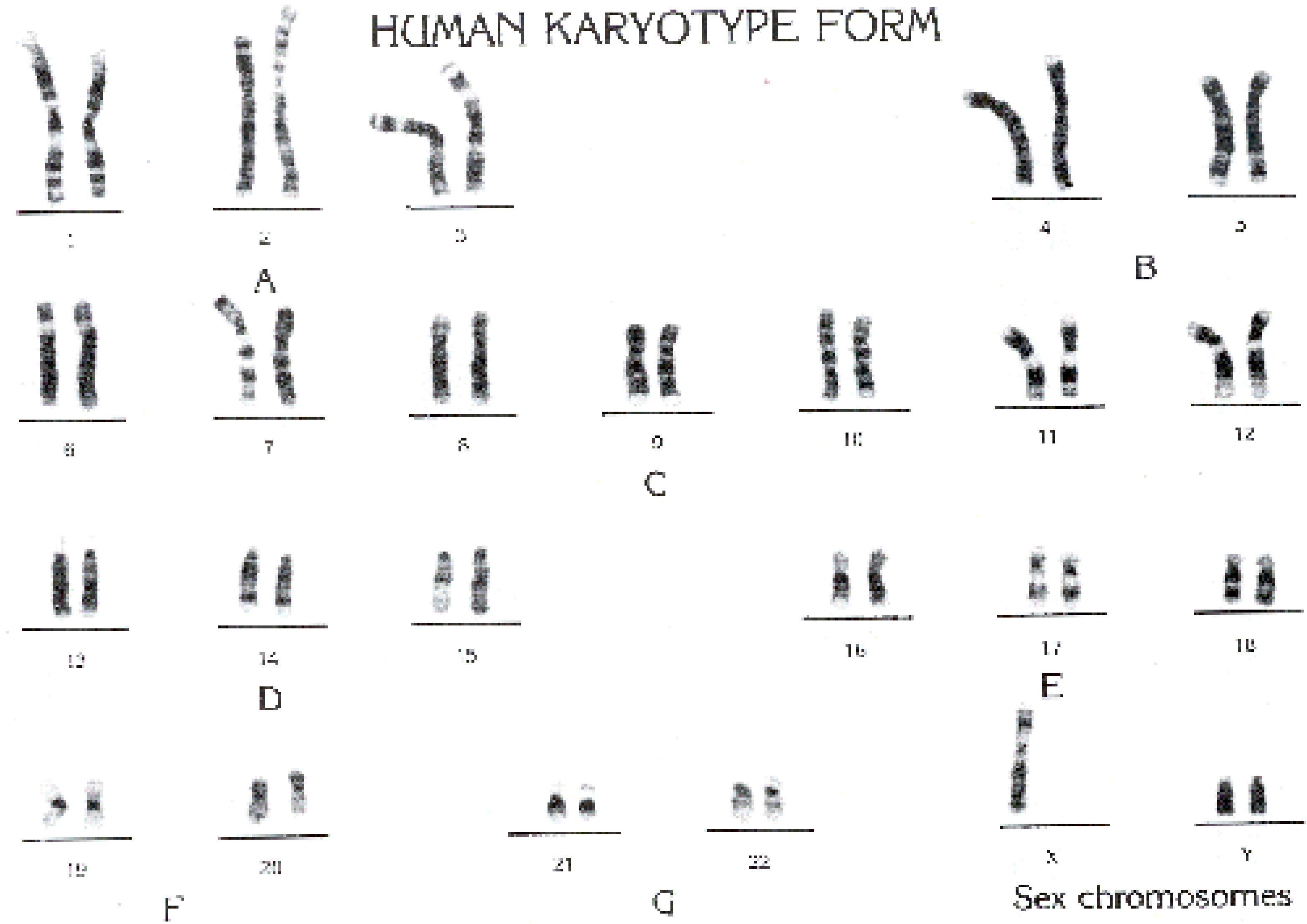


Plate Two

GENETIC DISORDERS

Trisomy 21

- Down's Syndrome
- Mental retardation
- Flattened facial features
- Thick tongue


HUMAN KARYOTYPE FORM
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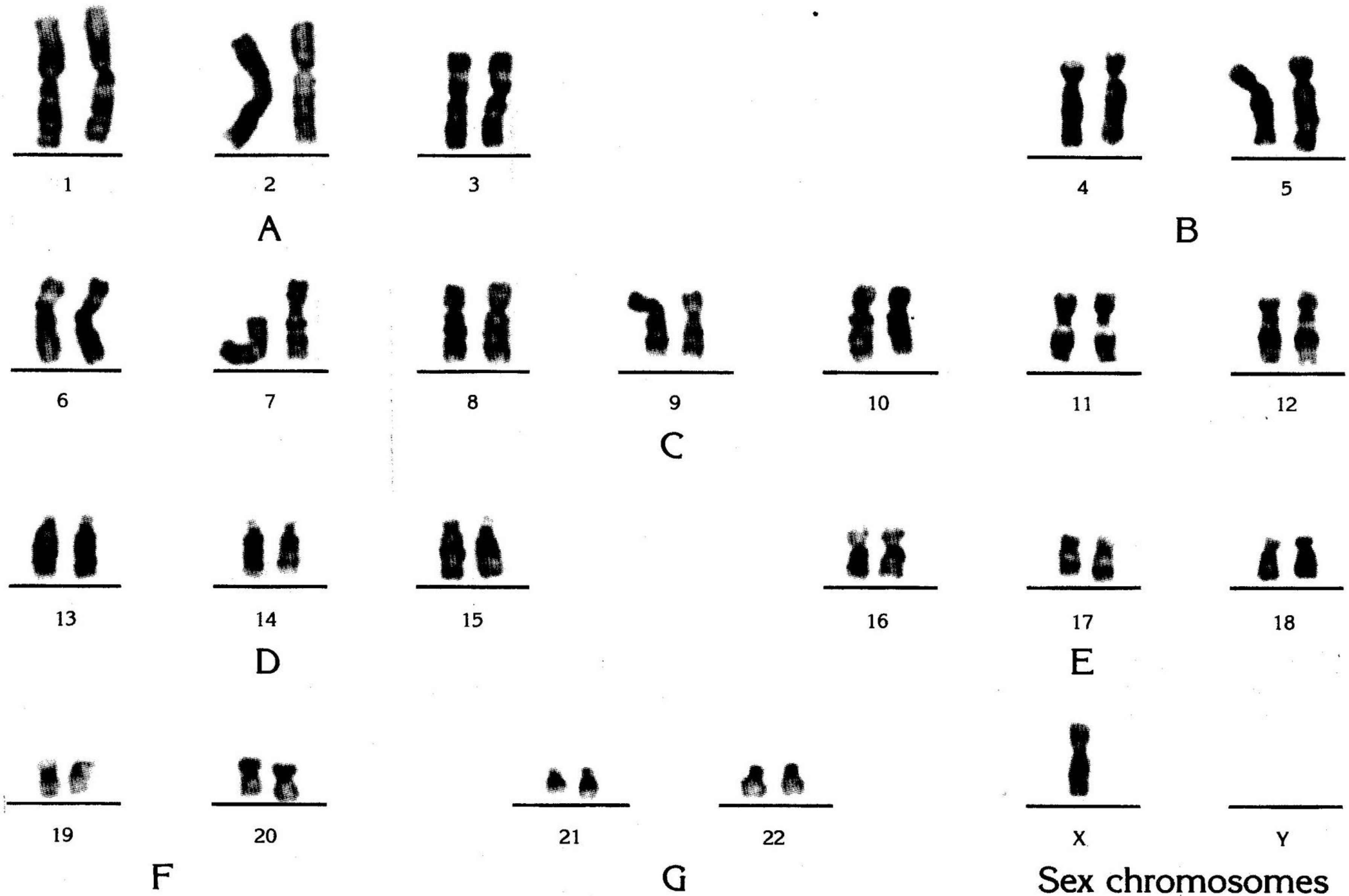
Sex chromosomes

Extra Y

- Male
- 1: 1000 births
- Normal in appearance
- Usually tall
- Often exhibit aggressive behavior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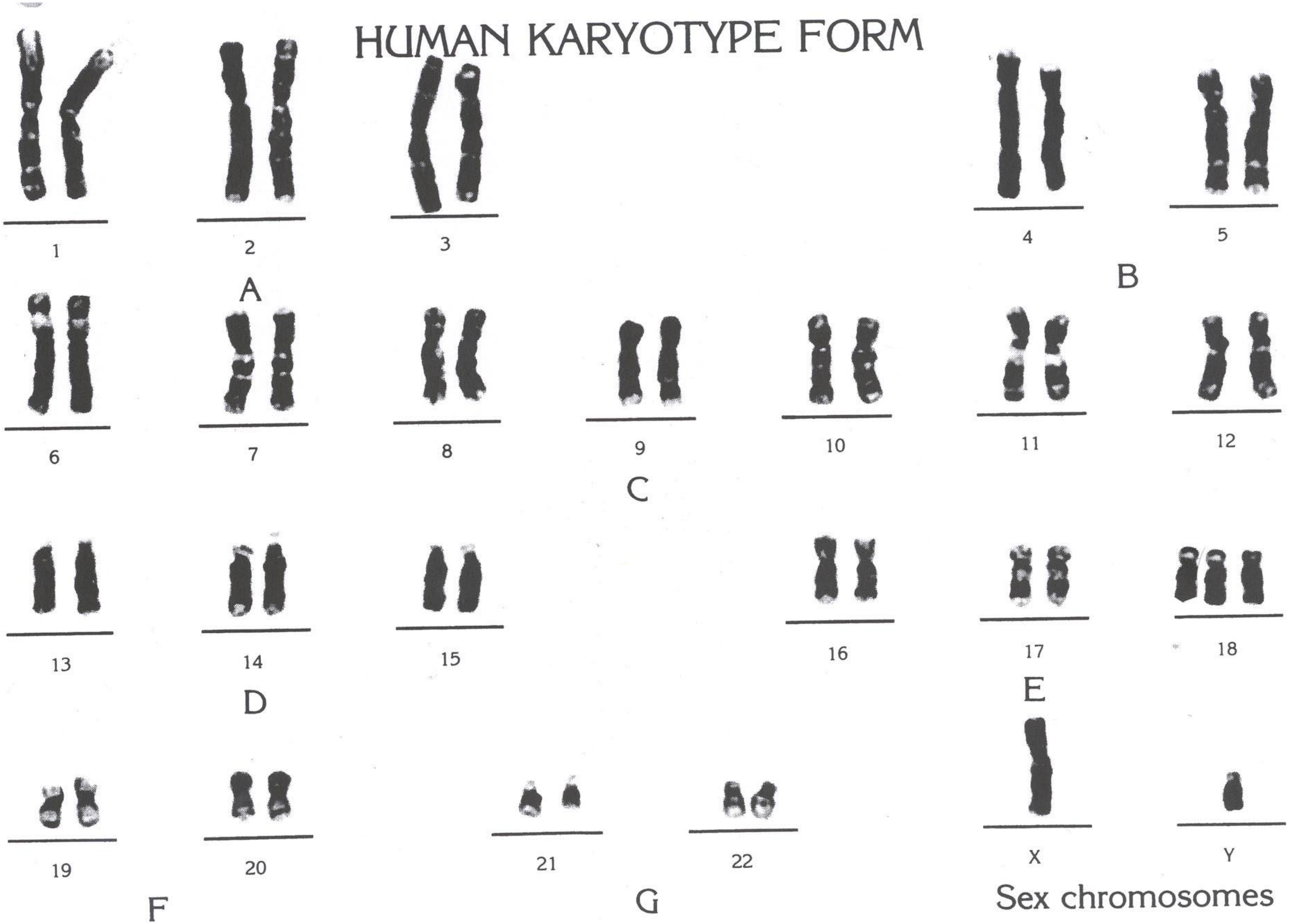
Sex chromosomes

Turner's Syndrome

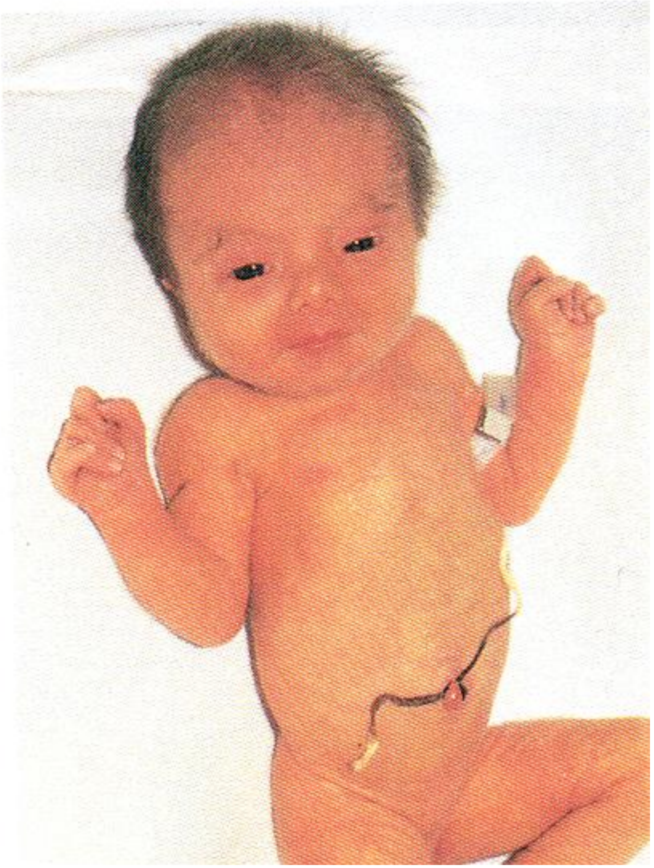
- Short webbed neck
- Do not mature sexually
- 99% spontaneously aborted

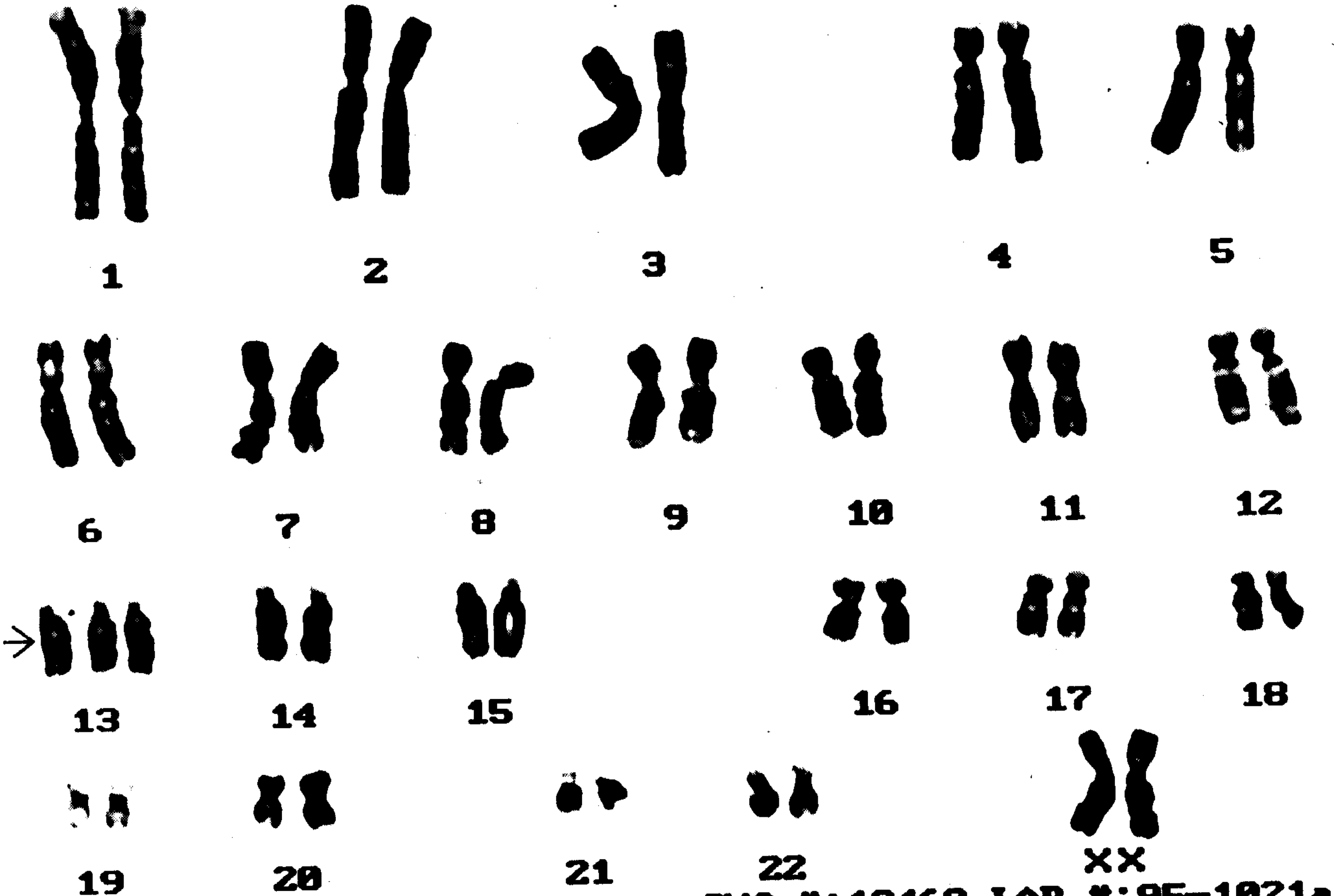
HUMAN KARYOTYPE FORM



Trisomy 18

- Edward's syndrome
- Mentally deficient
- Low set ears
- Short sternum
- Growth retardation
- 1: 8000

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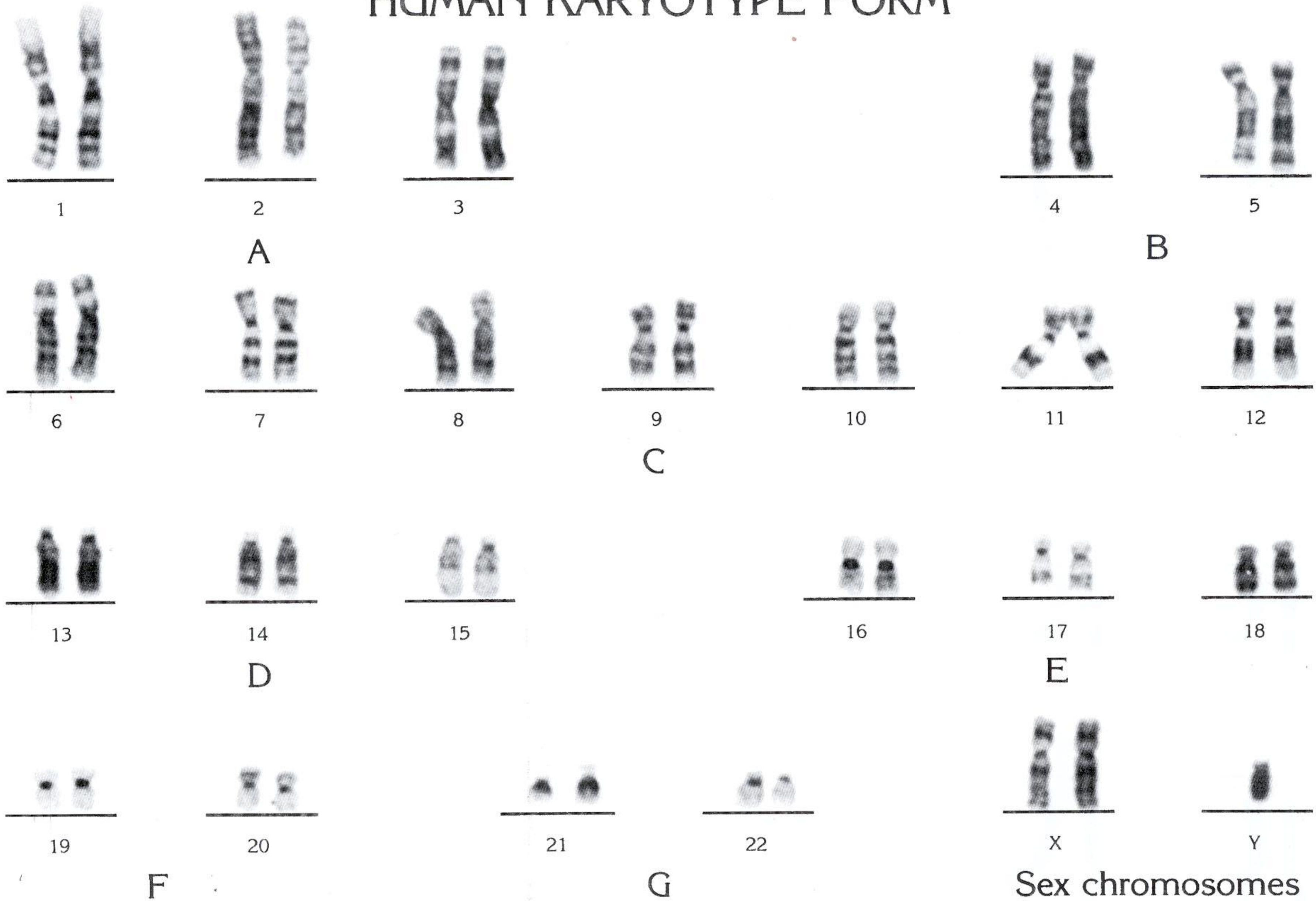
Trisomy 13

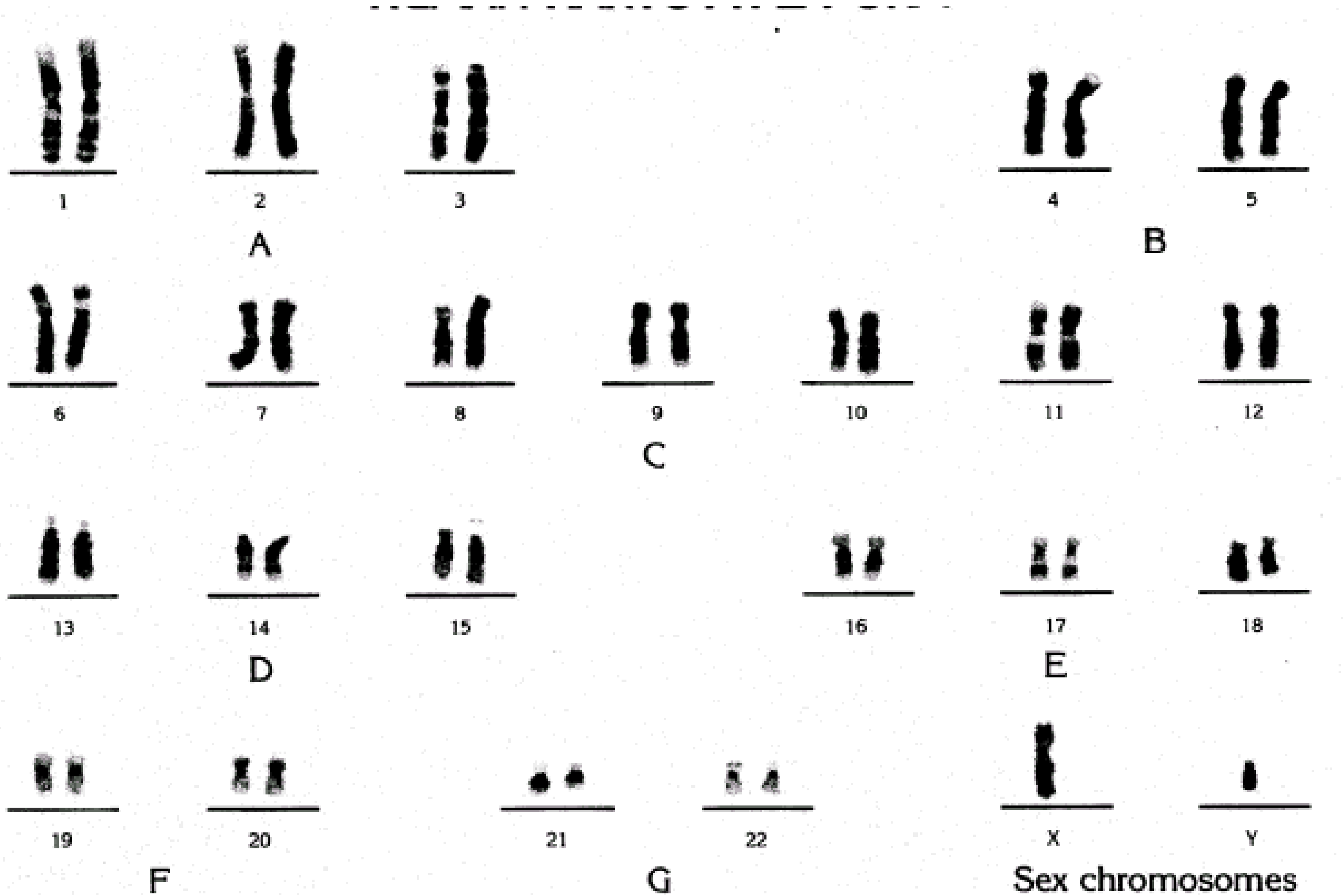
- Patau Syndrome
- Severe malformations of facial and nervous system
- mental deficiency
- 1: 25,000

HUMAN KARYOTYPE FORM



Klinefelter’s Syndrome

- Extra X
- 1: 1000 births
- Tall
- Lower intelligence
- Often infertile
- male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Sex chromosomes

Cri du Chat

- Deletion of 5 p
- Cat like cry
- Small head
- Severe retardation
- Heart problems

PEDIGREES

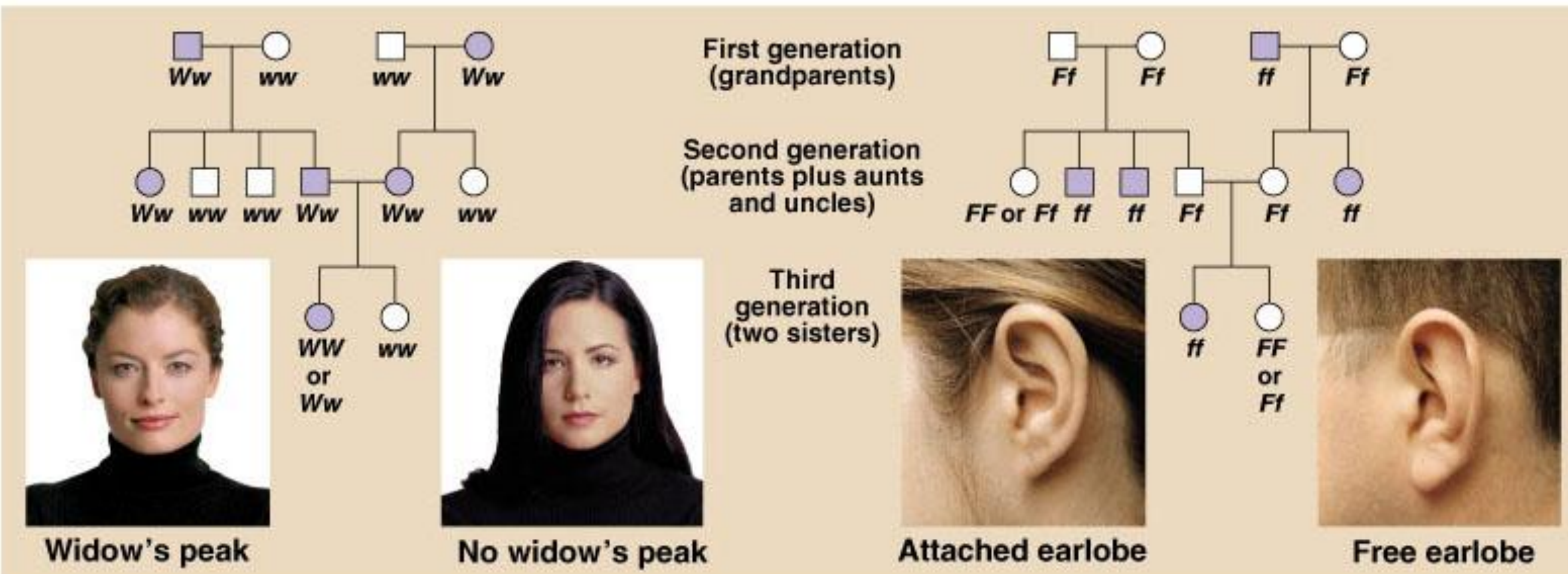
Figure 14.14 Pedigree analysis

Widow's Peak:

A dominant trait

Attached Earlobes:

A recessive trait



Pedigree: **Map** shows the appearance of a **trait** in a **family tree**

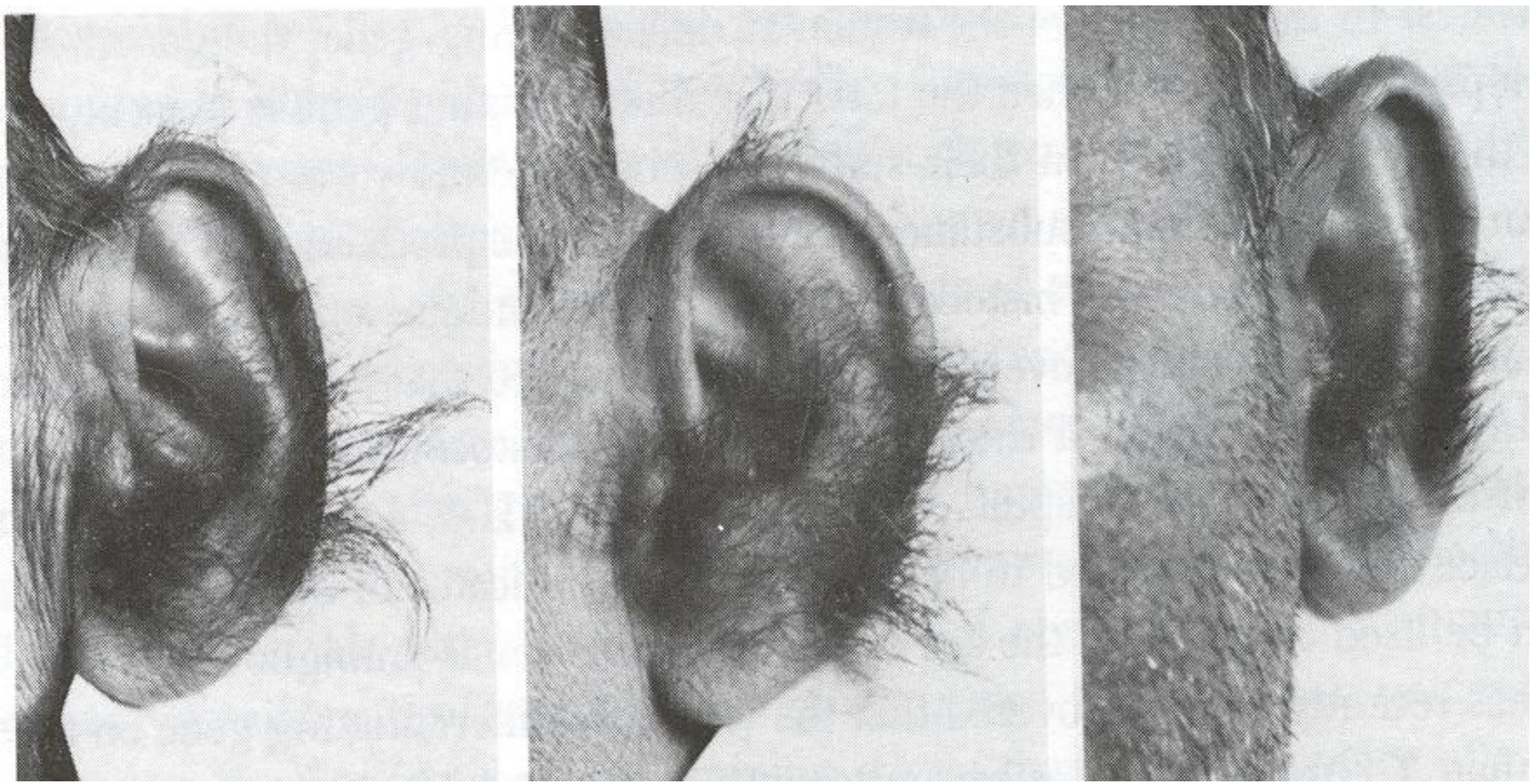
■ = Male Affected by Trait

□ = Male Not Affected by Trait

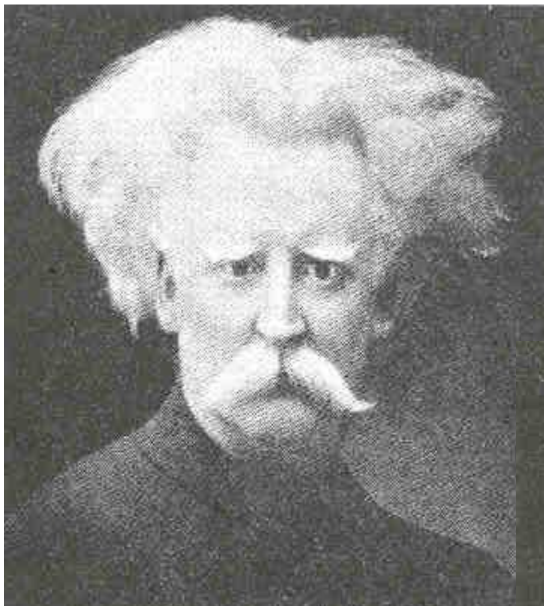
● = Female Affected by Trait

○ = Female not affected by Trait

Hairy Ear Lobes



Albinism



Polydactyl