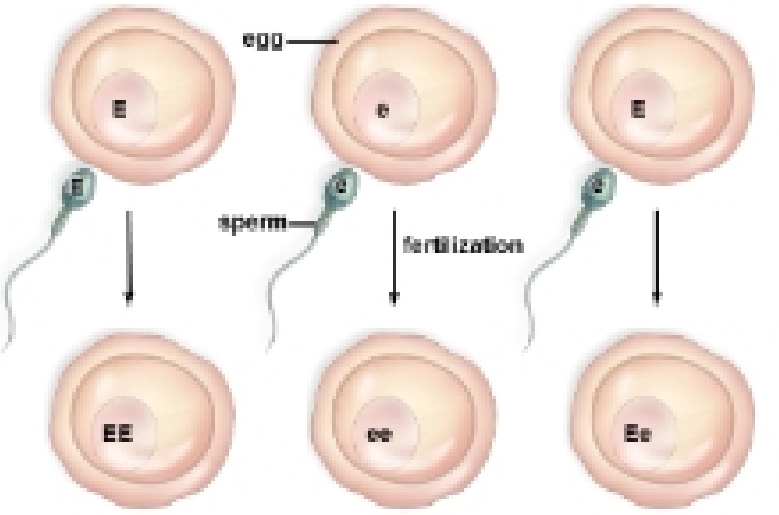
Chapter 20: Genetic Inheritance

- Genotype – genetic make-up for a particular trait; written with symbols
  - Alleles are alternate forms of a specific gene at the same position (locus) on a gene (e.g., allele for unattached earlobes and attached lobes); alleles occur in pairs.
  - A dominant allele (eg. T) will be expressed and will mask a recessive allele (Tt or TT).
  - A recessive allele (eg. t) is expressed only when a gene has 2 of this type of allele (tt).

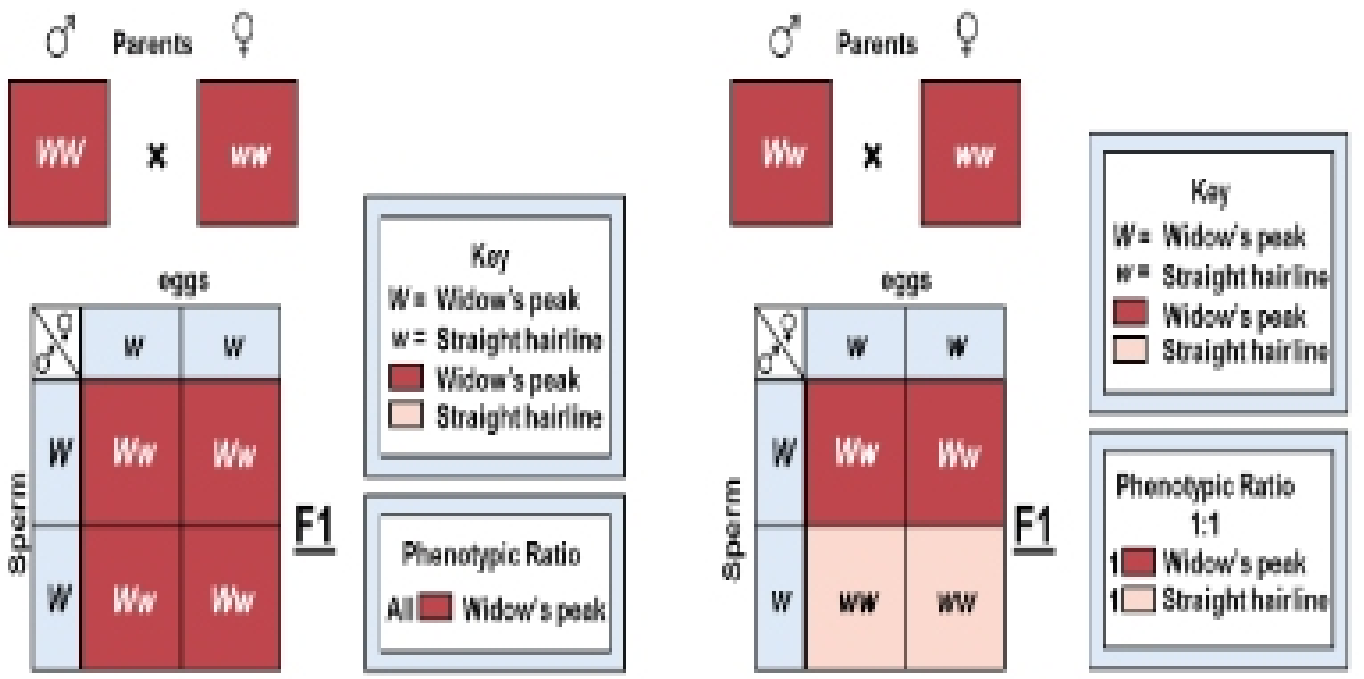
- A homozygous dominant genotype consists of 2 dominant alleles (TT or AA).
- A homozygous recessive genotype consists of 2 recessive alleles (tt or aa).
- A heterozygous genotype consists of 1 dominant allele and 1 recessive allele (Tt or Aa).

- Phenotype - the physical or outward expression of the genotype

Genotype	Phenotype
EE	unattached earlobe
Ee	unattached earlobe
ee	attached earlobe

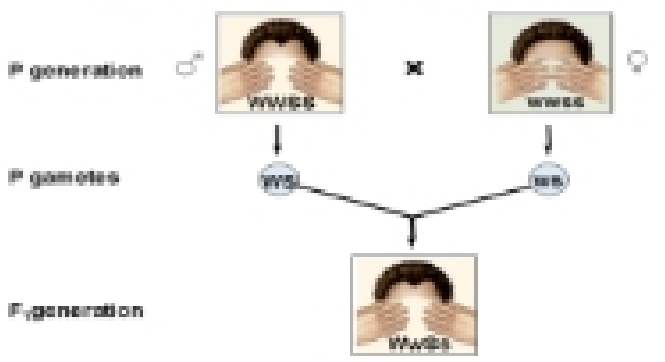


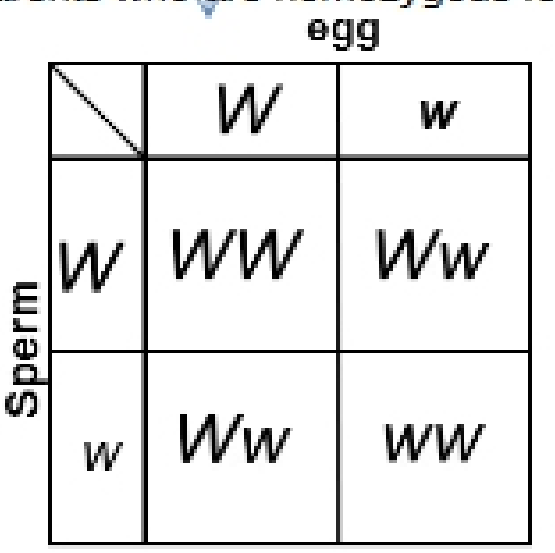
- Crosses
  - One-trait ('monohybrid') cross – involves inheritance of alleles for 1 gene / character
    - e.g. WW x Ww



So, in F2 generation for a monohybrid cross originating from parents who are homozygous for the 2 alleles of 1 gene:

- Phenotypic ratio = 3:1;
- Genotypic ratio = 1:2:1.

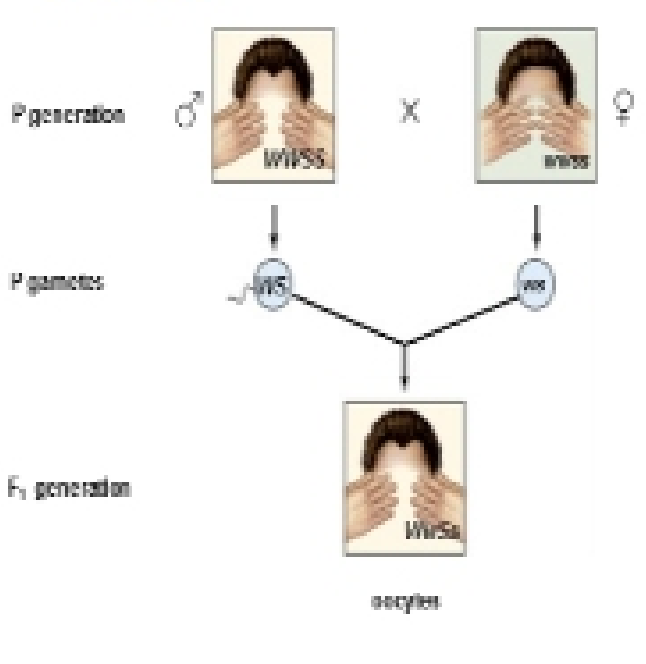


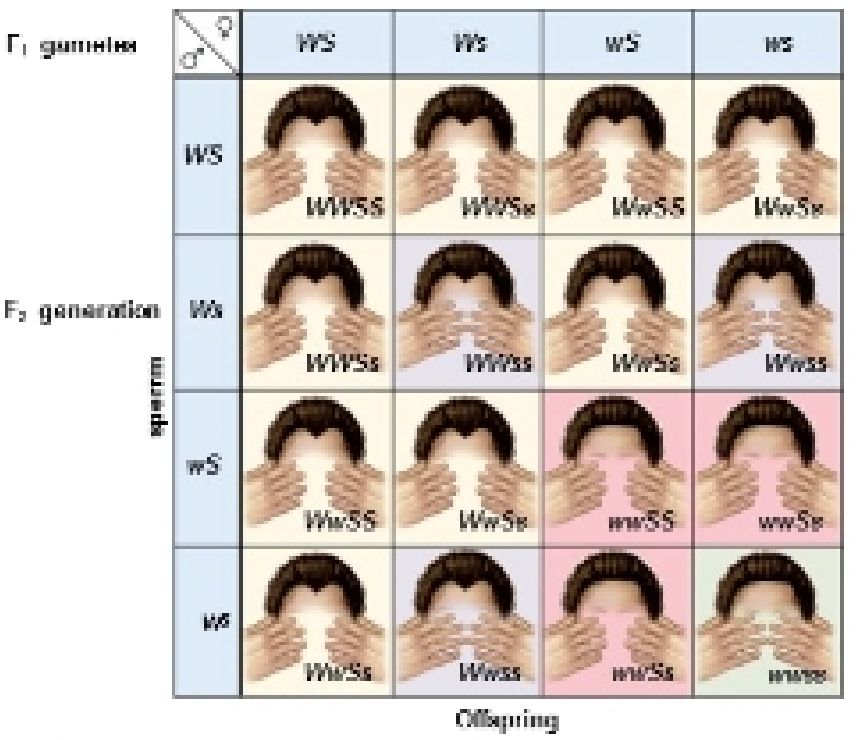


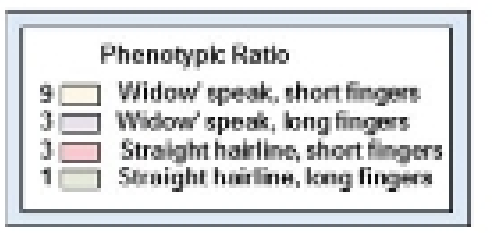
- Two-trait ('dihybrid') cross – considers inheritance of 2 genes / characters. An experimental cross usually involving parents who are homozygous for different alleles of 2 genes

- e.g. WWTT x WwTT
- Results in a 9:3:3:1 phenotypic ratio for offsprings in F2.

What would the Punnett square look like for a dihybrid cross between a male who is WWSS and a female who is wwss?







Offspring

Table 20.1 Phenotypic Ratios of Common Crosses

Genotypes	Phenotypes
Monohybrid *Gg* × monohybrid *Gg*	3:1 (dominant to recessive)
Monohybrid *Gg* × recessive *gg*	1:1 (dominant to recessive)
Dihybrid *GgRr* × dihybrid *GgRr*	9:3:3:1 (9 both dominant: 3 one dominant: 3 other dominant: 1 both recessive)
Dihybrid *GgRr* × recessive *ggrr*	1:1:1:1 (all possible combinations in equal number)

- A Gamete carries only 1 allele, so if an individual has the genotype Ww, what are the possible gametes that this individual can pass on?
  - Answer: either a 'W' or a 'w', but not both

- Punnett Squares
  - The use of a grid to diagram crosses between individuals by using the possible parental gametes.
  - These allow one to determine the probability that an offspring will have a particular genotype and phenotype.

- Practicing Punnett squares
  - What would a Punnett square involving a man (M) with a genotype Ff and a woman (F) with a genotype Ff look like?
    - F – freckles
    - f – no freckles

- Practicing ratios
  - Genotypic ratio is the number of offsprings with the same genotype.
  - Phenotypic ratio is the number of offsprings with the same outward appearance.

What is the genotypic ratio? 1: 2: 1 (1 FF: 2 Ff: 1 ff)
What is the phenotypic ratio? 3: 1 (3 with freckles and 1 with no freckles

Pre-implantation genetic disorders

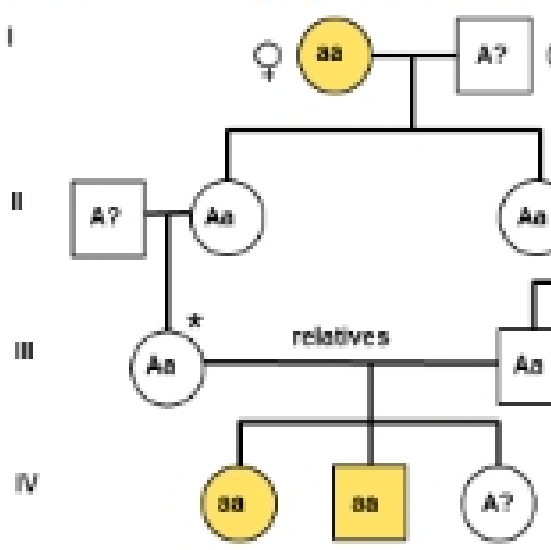
- If prospective parents carry an allele for a genetic disorder, they may seek assurance that their offspring will be free of the disorder
- Following in vitro fertilization (IVF), the zygote divides.
- When the embryo has 8 cells, 1 cell may be removed for genetic testing.
- Only embryos that will not have the genetic disorders of interest are placed in the uterus to continue developing.

Autosomal recessive disorder

Individuals must be homozygous recessive to have the disorder.

(Homozygous recessive-> only recessive, no dominant alleles.

Small a, small a {aa} means autosomal recessive disorder)



Autosomal recessive disorders

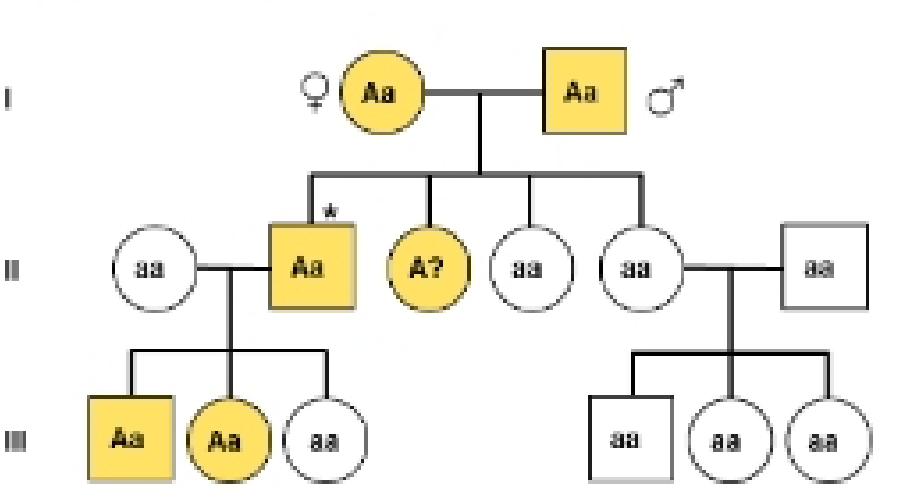
- Affected children can have unaffected parents.
- Heterozygotes (Aa) have an unaffected phenotype.
- Two affected parents will always have affected children.
- Affected individuals with homozygous unaffected mates will have unaffected children.
- Close relatives who reproduce are more likely to have affected children.
- Both males and females are affected with equal frequency.

Autosomal dominant disorder

Individuals that are homozygous dominant OR

heterozygous will have the disorder. Capital A, Capital A

or Capital A, small A



Autosomal dominant disorders

- Affected children will usually have an affected parent.
- Heterozygotes (Aa) are affected.
- Two affected parents can produce an unaffected child.
- Two unaffected parents will not have affected children.
- Both males and females are affected with equal frequency.

An Autosomal recessive disorder of interest

- Sickle-cell anemia – due to 1 amino acid change, hemoglobin is mutated; red blood cells are sickle-shaped rather than biconcave, resulting in clogged blood vessels. (not enough oxygen supply results in anemia)

An Autosomal dominant disorder of interest

- Huntington disease – huntington protein mutated due to too many glutamine amino acids, leading to progressive degeneration of brain cells

Likewise, there are Sex-Linked traits or disorders (either X chromosome-linked or Y chromosome-linked).
Eg. Color Blindness: X chromosome linked. (recessive) Its expressed X small b Y. (recessive trait) (Males are more likely to have this)

- Polygenic inheritance
  - Polygenic traits – 2 or more sets of alleles govern 1 trait.
    - ✓ Each dominant allele codes for a product, so these effects are additive.
    - ✓ This results in a continuous variation of phenotypes.
    - ✓ Environmental effects cause intervening phenotypes.
    - ✓ e.g., skin color ranges from very dark to very light
    - ✓ e.g., height varies among individual humans