Cells and Heredity

Chapter 3: Genetics – The Science of Heredity

8th Grade

Lesson 1 (What is Heredity?)

Heredity – the passing of physical characteristics from parents to offspring.

Trait – a characteristic that an organism can pass on to its offspring through its genes on its chromosomes.

Genetics – the scientific study of heredity.

Mendel – Austrian monk who was the first to show the inheritance of traits through his work with pea plants (often called the "Father of Genetics")

Purebred – the offspring of many generations that always have the same traits as the parents

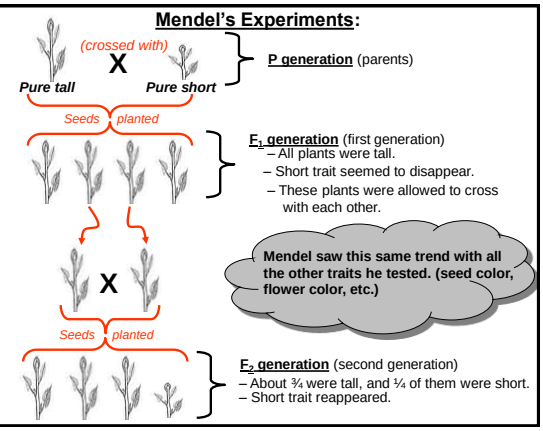
– Mendel made sure to start his experiments with purebred plants so he could be sure of his results.

Fertilization – the joining of sperm from a male with the egg of a female organism.

– All traits in any organism are decided at **fertilization**.

Cross – a controlled mating between a male and female organism

Mendel's Experiments:



Mendel's Conclusions:

– Some "factors" (or sets of information) are responsible for the inheritance of traits.

– These "factors" that control each trait exist in pairs.

– The female contributes one "factor", and the male contributes the other "factor".

– One "factor" in a pair can mask or cover up the other factor to make it seem to disappear.
(Tallness masked shortness in one of his studies.)

gene – a segment of DNA on a chromosome that contains information to decide a trait.

– Organisms have two genes for each trait, located on two matching chromosomes. (Genes occur in pairs because chromosomes are in pairs.)

Example: We have two genes for earlobe shape, two for hair texture, and so on.

alleles – the different forms of a gene

– Each organism inherits two alleles for each trait from its parents – one allele from the mother (in the egg), and one allele from the father (in the sperm).

Example: You might have one allele for blue eyes (from Mom), and one allele for green eyes (from Dad).

Dominant allele – an allele whose trait always shows up when this allele is present

– A dominant allele will cover up, or mask another trait.

Recessive allele – an allele whose trait is masked (hidden, or covered up) when the dominant allele is present.

– A trait controlled by a recessive allele will show up only when an organism does not have the dominant allele.

Example: A person may have 2 dominant alleles for eye color (say blue). Eyes will be blue.

OR

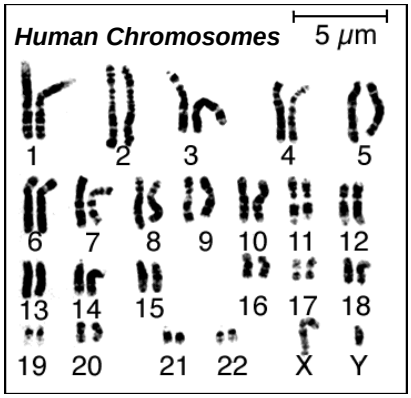
He/she may have 2 recessive alleles for eye color (say brown). Eyes will be brown.

OR

He/she may have one dominant (blue) and one recessive (brown) allele for eye color.

Eyes will be blue because blue is dominant over brown.

All other traits work the same way.



hybrid – an organism that has two different alleles for a trait (one dominant and one recessive allele)

Symbols for Alleles:

1. capital letter – represents a dominant allele
2. lowercase letter – represents a recessive allele
3. The letter selected usually represents the dominant trait.

Example: If tall is the dominant trait and short is the recessive trait:

T* = *tall ***t* = *short***

tt – when a plant has 2 recessive alleles (plant will be short)

TT – when a plant has 2 dominant alleles (plant will be tall)

Tt – when a plant has 1 dominant and 1 recessive allele (plant will be tall)

Example: If blue eyes is dominant over green eyes:

B* = *blue eye allele ***b* = *green eye allele***

BB – will have blue eyes

bb – will have green eyes

Bb – will have blue eyes

Heterozygous – having two different alleles for a trait (one dominant, **and** one recessive allele)

– Hybrids are heterozygous.

Examples: *Rr, Bb, Tt,* etc.

Homozygous – having two of the same alleles for a trait (two dominant, **or** two recessive alleles)

Examples: *RR, bb, TT, rr,* etc.

Pure dominant – having two dominant alleles for a trait (*BB, RR, TT,* etc.)

Pure recessive – having two recessive alleles for a trait (*bb, rr, tt,* etc.)

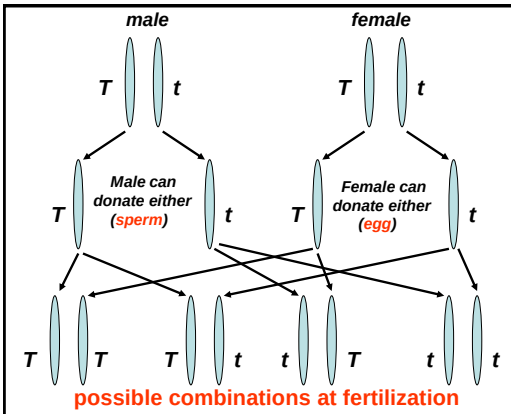
Lesson 2 (Probability and Heredity)

Probability – a number that describes how likely something will happen.

– Probability predicts what is likely to happen, not what will actually happen.

Example: The probability that a coin toss will be tails is 1 in 2.(or ½ or 50%)

Out of 100 tosses – you would expect 50 heads, 50 tails (You may not actually get that though.)

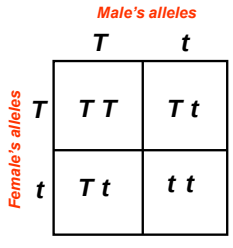


Punnett square – a chart that shows all the possible combinations of alleles that can result from a genetic cross

– They are used to determine the probability (or likelihood) of a particular outcome in a cross.

Genotype – an organism's allele combinations (genetic makeup)

Phenotype – an organism's physical appearance, or visible traits because of its genotype



T = tall (dominant)

t = short (recessive)

Each offspring has a 75% chance of being tall

Each offspring has a 25% chance of being short

If the plant produced 4 seeds, and you planted them to let them grow, you would expect to get 3 tall plants and 1 short plant.

Lesson 3 (Patterns of Inheritance)

Most traits are the result of complex patterns of inheritance:

1. Incomplete dominance
2. Codominance
3. Multiple alleles
4. Polygenic inheritance

Codominance – a condition in which neither of the two alleles of a gene is dominant or recessive

– A combination of the two traits shows up in the offspring.

Example : A plant with red flowers is crossed with a plant with white flowers and you get plants with white flowers with red streaks in them (neither white, nor red).

Incomplete Dominance

– another condition in which neither of the two alleles of a gene is dominant or recessive

– The phenotype resembles a sort of blending of the two alleles.

Example: A plant with red flowers is crossed with a plant with white flowers and you get plants with pink flowers (neither white, nor red).

Some human traits are controlled by a **single gene that has several alleles**. (**multiple alleles**)

Multiple alleles – 3 or more forms of a gene that code for a trait

– A person can carry only two of the alleles because chromosomes are in pairs and each chromosome carries only one allele for each gene.

Example: blood type (There are more than 2 blood types.)

Some human traits are controlled by **multiple genes.**
(More than one gene works together to determine the trait.)

Polygenic inheritance – occurs when more than one gene affects a trait

Examples: height and skin color

Many traits are determined by both genes and a person's **environment**.)

Examples:

– Height is influenced by many genes working together, but diet also plays an important role.

– Genes may control personality, but so does the person's environment.

– Genes may determine coordination and other skills of a good athlete, but so does that person's environment (coaching, practice, commitment).

– Things in the environment can affect the genes in an organism, such as causing cancers.

Lesson 4 (Chromosomes and Inheritance)

Cell division allows organisms to:

1. grow
2. repair damaged structures
3. reproduce

Body cells:

– most numerous type of cell in your body

– produce 2 identical copies of themselves by **mitosis**

– contain twice the number of chromosomes as sex cells

Examples: muscle cells, bone cells, nerve cells, skin cells, etc.
Humans have **46** chromosomes (or 23 pairs) in each body cell.

Sex cells – reproductive cells in the body

– produced by **meiosis**

– contain ½ the number of chromosomes as body cells

Examples: eggs and sperm
Humans have 23 chromosomes in each sex cell.

The Cell Cycle – the regular sequence of growth and division that body cells undergo

– Two new "daughter" cells are produced from one "parent" cell.

Mitosis – the stage during the cell cycle during which the cell's nucleus divides into two nuclei and one set of DNA is distributed into each daughter cell during the making of new **body cells**

Meiosis – the process by which the number of chromosomes is reduced by half to form sex cells (sperm and eggs)

– Meiosis occurs only in the **ovaries** of females and the **testes** of males.

Why do sex cells need ½ the number of chromosomes?

egg
23 chromosomes

sperm
23 chromosomes

offspring
46 chromosomes

When sperm and egg unite during fertilization, the offspring must have the correct number of chromosomes in each of its body cells.