Life Science
Chapter 7

Genetics of Organisms

7A – The Origin of Modern Genetics

Genetics – the study of inheritance (the study of how traits are inherited through the interactions of alleles)
Heredity: the passing of traits (physical characteristics) from parent to offspring

Gregor Mendel's work was done about 140 yrs. ago, but even now much of what we know about genetics is based on Mendel's work and illustrated by it.

Gregor Mendel was born in 1822 on a farm in Heinzendorf, Austria.
At age 21 entered the Augustinian order of the Roman Catholic Church.
As a monk he - studied science at the University of Vienna and became an excellent mathematician.
As a school teacher - he engaged in many scientific activities.
At a monastery - he began a program of selective breeding of peas.

After 8 yrs. of raising 30,000 pea plants and recording and classifying many pages of notes, he wrote a paper describing his experiments and stating his theories. The paper was called **Mendelian Genetics** (1865). His paper was the first recorded study of how traits pass from one generation to the next. Mendel also was the first to use the mathematics of probability to explain heredity.

When Mendel's paper was published, in 1866, it received little attention, and was rarely cited by botanists or biologists during the next 34 years. The cause of this lack of recognition has been the subject of great speculation. Mendel's work has been thought to exemplify everything from the failure of traditional modes of scientific communication to the phenomenon of "premature scientific discovery". Whatever the reason, we know that in 1900, Mendel's work was cited by three botanists, writing in different parts of Europe: Hugo de Vries, in Amsterdam; Carl Correns, in Tübingen; and Eric Von Tcshermak, in Esslingen, Austria. Although their interpretations of what Mendel had shown were arguably inaccurate, these citations caused what has come to be known as the "rediscovery" of Mendel

In 1868 Mendel became the abbot of the monastery and gave up most of his scientific work.
In 1884 he died of a kidney disorder.
Mendel- *the father of genetics*.

Mendelian Genetics

Mendel observed 7 different contrasting sets of characteristics in peas. (garden pea plants 6 ft. or 2 ft. tall; either green or yellow; round or wrinkled, etc.)

The flower of the pea plant made it ideal for genetic experimentation.

The petals are arranged so that the pollen (contains male gamete) naturally fertilizes the pistil (contains female gamete) self-pollination

To cross-pollinate - he had to tear open the petals and move the pollen sack before they matured. He could supply pollen from another pea flower.

Mendel began with peas that had been self-pollinating.
Tall plants always produced tall plants (short-short)
He called these the parent plants P_1 (pure-bred)

He cross-pollinated a tall with short
Offspring called the first filial generation F_1(hybrids) (all were tall)
Allowed F_1 plants to self-pollinate and produce 2^{nd} filial generation
F_2 - of 1,064 plants 787 tall 277 short

An **allele** is one member of a pair or series of different forms of a gene (the different forms of a trait that a gene may have) (different forms of a gene)

An example is the gene for blossom color in many species of flower — a single gene controls the color of the petals, but there may be several different versions (or alleles) of the gene. One version might result in red petals, while another might result in white petals. The resulting color of an individual flower will depend on which two alleles it possesses for the gene and how the two interact.

purebred – an organism that is the offspring of parents with similar genetic makeups; usually the result of many generations of such breeding (homozygous) (both genes the same) (having identical factors)

hybrid – an offspring of two genetically unrelated individuals (an offspring that was given different genetic information for a trait from each parent) (genes different)
(heterozygoous) (having factors that are different) (has two different alleles for a trait)
a hybrid was the result of a cross between two different purebred organisms

cross – mating of organisms to test how they inherit traits

first filial generation (F1) - the 1st generation of offspring of a genetic cross
The word filial comes from *filia* and *filius*, the Latin words for “daughter” and “son.”

Mendel's Theories

(1) the concept of unit characteristics.

Mendel stated that an organism's characteristics are caused by units which he called factors (now called genes) which occur in pairs.

if factors were the same - **purebred** TT tall tt short
if factors were not the same - **hybrid** Tt tall

genotype: the genetic traits of the organism (genetic makeup or allele combinations) (when writing a genotype, the dominant trait is always listed first)

phenotype: the physical traits of the organism (its physical appearance or visible traits)

(2) the concept of dominant and recessive.

F_1 generation Tt why not medium-sized? they were tall
Dominant trait - the trait that expresses itself when factors for 2 opposing traits are present

Recessive trait - the trait that is masked (hidden) when 2 genes for opposing traits are present. The dominant gene completely masks the presence of the recessive gene.
purebred dominant, purebred recessive, hybrid

(3) the concept of segregation

Mendel reasoned that when a cell forms gametes, the factors separate (segregate) so that there is only 1 factor for each characteristic is in each gamete

The theories that Mendel discovered are now called: Principles of Heredity

(1) Traits are controlled by alleles on chromosomes.
(2) An allele's effect is dominant or recessive.
(3) When a pair of chromosomes separates during meiosis the different alleles for a trait move into separate sex cells.

----------Quiz 7A

Pedigree Charts with dominant & recessive problems (see powerpoint)

A pedigree is a visual tool for following a trait through generations of a family.
Males are represented by squares and females by circles.
A completely filled circle or square shows that the trait is seen in that person.
Half-colored circles or squares indicate carriers. A carrier is heterozygous for the trait, and it is not seen.
An empty circle or square means they do not have the trait and they are not carriers.

----------Quiz 7B

Punnett Squares

Geneticists often use **Punnett squares** to depict genetic crosses and to determine the possible gamete combinations of the offspring.
Punnett square: a diagram used to visualize genetic crosses (a chart that shows all the possible combinations of alleles that can result from a genetic cross)
It is a special chart, or grid system, named after its inventor Reginald C. Punnett. (devised in the early 1900's)
On the top- the possible gametes of the female are listed.
Down the left side- the possible gametes of the male are listed
The gametes are then combined in each of the boxes within the square to give the possible gamete combinations of the offspring.
Besides showing possible gene pairings, a Punnett square gives the probability of each pairing.
It shows how often, on the average, a given pairing will occur.

Punnett squares cannot tell which traits a specific offspring will exhibit but rather the chance, or odds, of having certain traits
The number of boxes in a Punnett square does not stand for the number of offspring an organism will produce.
The boxes represent the genetic possibilities of the offspring.

A small # of offspring- may not have the exact ratio of gene pairings.

purebred dominant purple plant X purebred recessive yellow plant

hybrid X purebred recessive

----------Quiz 7C

Variations in Mendel's Theories

Not all genetic traits are either dominant or recessive.

(1) Incomplete dominance

incomplete dominance- a type of inheritance in which the genes expressing a particular characteristic are neither dominant or recessive; two traits combine or blend together to produce a different trait (a blend of two traits) (when offspring of two homozygous parents show an intermediate phenotype)

example: flower color in snapdragons & four o'clock flowers
purebred red X purebred white --> all pink offspring
cross two pink snapdragons --> 1/4 white, 1/2 pink, 1/2 red

for incomplete dominance use two different letters to represent genes

(2) Codominance

In codominance the dominant and the recessive traits are both expressed.
Example: roan cattle

In incomplete dominance neither allele is fully dominant. This is different from codominance, in which both alleles are fully expressed, resulting in organisms that display the characteristics of both parents.

(3) Multiple gene inheritance

multiple gene inheritance (also called Polygenic Inheritance)- two or more gene producing a single trait (examples: hair color, skin color, eye color, height, intelligence, body build, etc.)

----------Quiz 7D

(4) Sex-Linked traits

INHERITANCE OF SEX CHROMOSOMES

humans - 23 pairs of chromosomes
22 pairs are non-sex determining chromosomes - called **autosomes**
the 23rd pair determines the sex of the offspring
female sex chromosomes - XX chromosomes
male sex chromosomes - 1 X chromosomes + 1 Y chromosomes (XY)
(y is smaller than x and has different genes)
men's sperm determines the child's sex

SEX- LINKED TRAITS

sex-linked traits – an inherited trait that has a gene on the x chromosome but no corresponding gene on the y chromosome (genes that only exist only on the sex chromosomes)

carrier - expresses the normal characteristic but has both dominant and recessive genes (have the gene for a trait but do not express the trait themselves)
examples: Hemophilia
Red-green color blindness
Muscular dystrophy
Male pattern baldness
for sex-linked traits, males **cannot** be carriers

INHERITED DISORDERS

inherited disorders - an abnormal trait passed on through genes
examples: red-green colorblindness
some handicaps

----------Quiz 7E