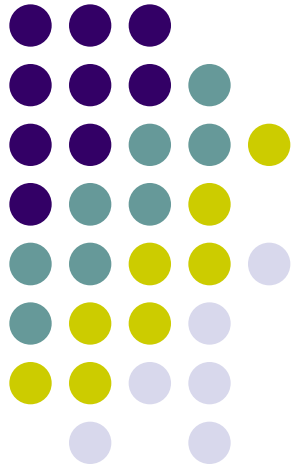
Heredity, Genetics, & Evolution

Knowledge of genetic mechanisms came as a result of careful laboratory experiments over the last century and a half



Hybrids Through Breeding

- For thousands of years farmers and herders have been selectively breeding their plants and animals in order to produce more productive hybrids.
- It was somewhat of a hit or miss process since the actual mechanisms governing inheritance were unknown.

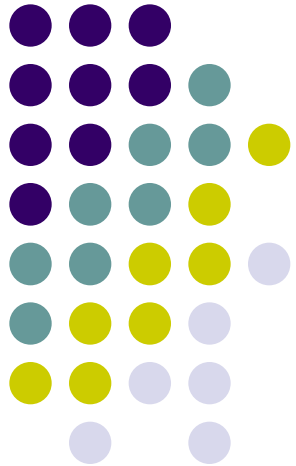
Chicken

Domesticated horses

Cracking the Code of Life:

Part 1

The instructions for a human being



Genetic Principles Discovered by Mendel

- Gregor Mendel (1822-1884) laid down the basic principles of heredity.
- Crossed different strains of purebred plants and studied their progeny.
- Worked with common garden peas and considered only one trait at a time.
- His work illustrates the basic rules of inheritance.

Heredity

Mendel's research was with plants, but the basic underlying principles of heredity also apply to people and other animals.

The mechanisms of heredity are essentially the same for all complex life forms.

Mendel's Experiments

Mendel picked common garden pea plants for the focus of his research because they can be grown easily in large numbers and their reproduction can be manipulated.

Today, bacterium and fruit flies are generally used for lab testing because they reproduce multiple generations very rapidly.

Generational Changes

In cross-pollinating plants that either produce yellow or green peas exclusively, Mendel found that the first offspring generation (f1) always has yellow peas.

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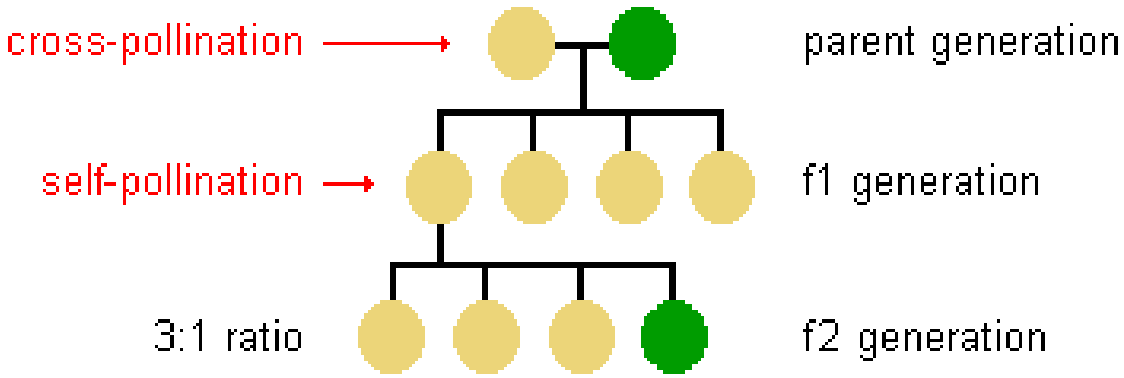
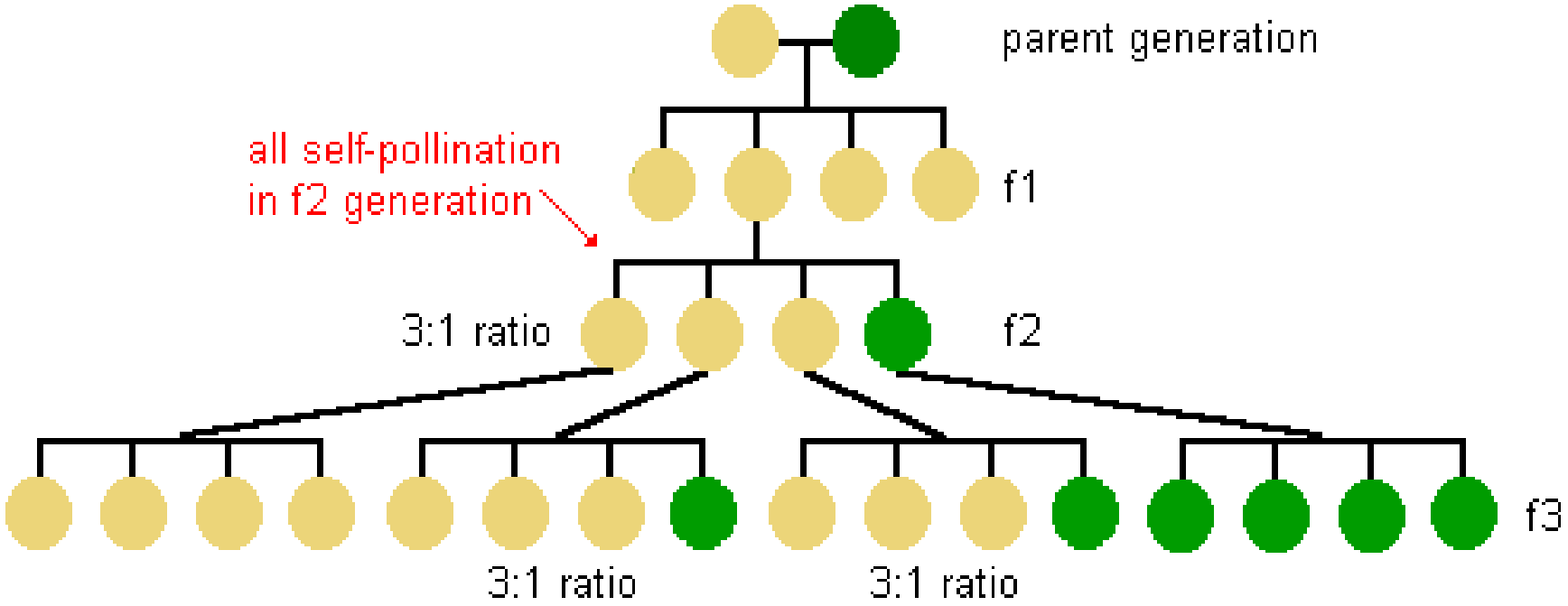


However, the following generation (f2) consistently has a 3:1 ratio of yellow to green.

This ratio is the key to understanding the basic mechanisms of inheritance.

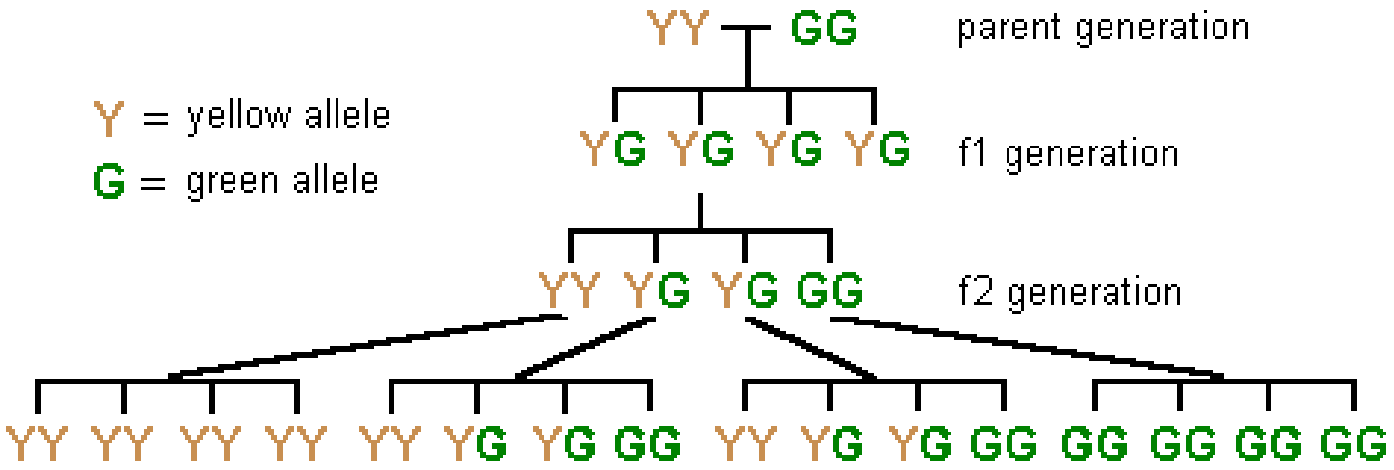


Three important conclusions:

- That the inheritance of each trait is determined by "units" or "factors" (now called genes) that are passed on to descendents unchanged.
- That an individual inherits one such unit from each parent for each trait.
- That a trait may not show up in an individual but can still be passed on to the next generation.

Homozygous and Heterozygous

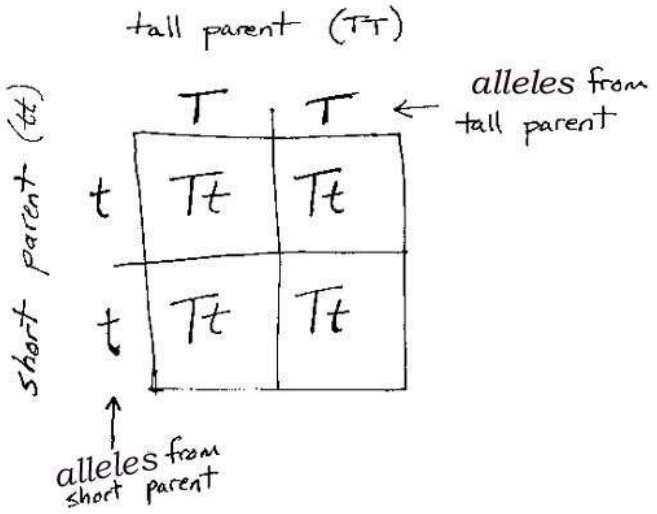
- The parent plants were homozygous for pea color - they each had two identical forms (or alleles) of the gene: 2 yellows or 2 greens.



- The plants in the f1 generation were all heterozygous for pea color - they each had inherited two different alleles (one from each parent plant).

Genotype and Phenotype

It becomes clearer when we look at the actual genetic makeup (genotype)…

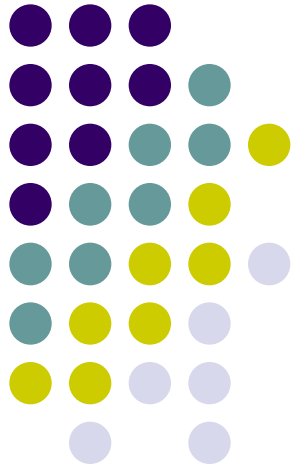


…of the pea plants instead of only the observable physical characteristics (phenotype).

Classical Genetics

Animations 1-5:

Children Resemble Their Parents 1.
Genes Come in Pairs 2.
Genes Don’t Blend 3.
Some Genes are Dominant 4.
Genetic Inheritance Follows Rules 5.



Mendel's observations can be summarized in two principles:

1. The principle of segregation:

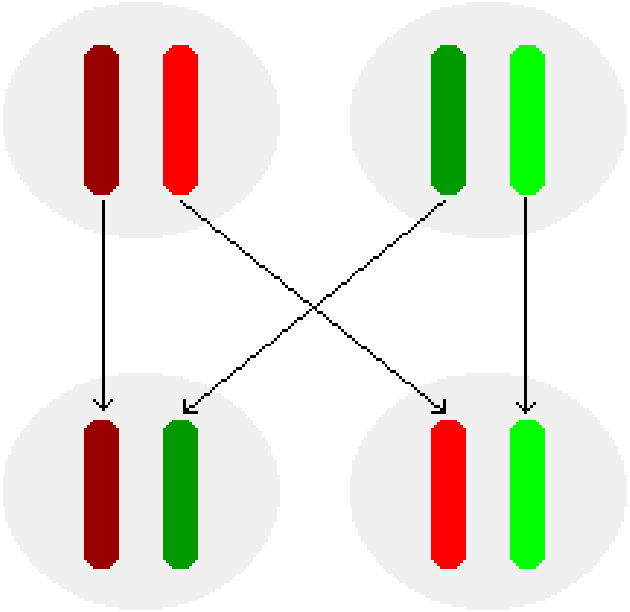
> For any particular trait, the pair of alleles of each parent separate and only one allele passes from each parent on to an offspring.

2. The principle of independent assortment.

> Different pairs of alleles are passed to offspring independently of each other with the result that new combinations of genes present in neither parent are possible.

The Principle of Segregation

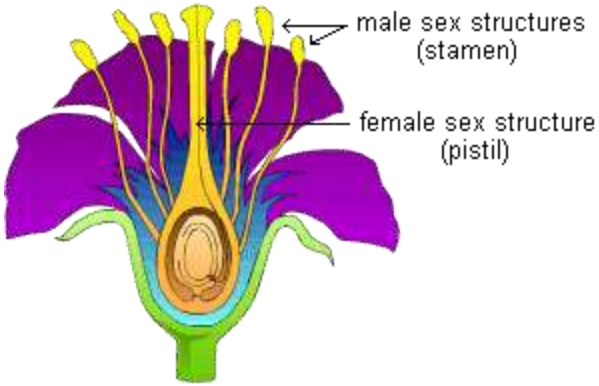
- Genes occur in pairs because chromosomes occur in pairs.
- During gamete production, members of each gene pair separate so each gamete contains one member of a pair.
- During fertilization, the full number of chromosomes is restored and members of a gene or allele pair are reunited.



Segregation of cells

The Principle of Independent Assortment

- The distribution of one pair of alleles into gametes does not influence the distribution of another pair.
- The genes controlling different traits are inherited independently of one another.

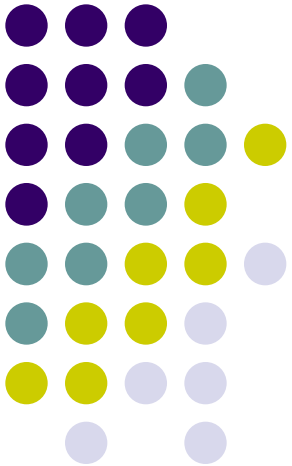


The genes for independently assorted traits are located on different chromosomes

Cracking the Code of Life

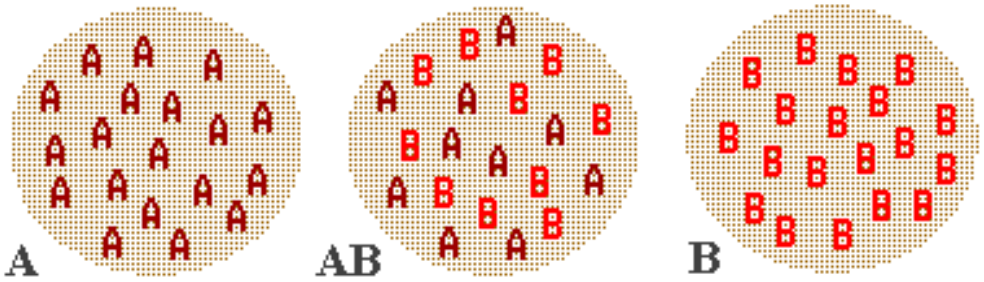
Part 12

Finding Disease Genes



Mendelian Inheritance in Humans

- Over 4,500 human trains are known to be inherited according to Mendelian principles.
- The human ABO blood system is an example of a simple Mendelian inheritance.
  - The A and B alleles are dominant to the O allele.
  - Neither the A or B allele are dominant to one another; They are codominant and both traits are expressed.



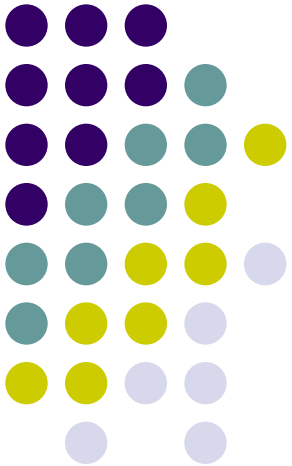
Inherited Genetic Disorders

- Genetic disorders can be inherited as dominant or recessive traits.
- Dominant disorders are inherited when one copy of a dominant allele is present.
- Recessive disorders require the presence of two copies of the recessive allele.
- Recessive conditions that affect humans: cystic fibrosis, Tay-Sachs disease, sickle cell anemia, and albinism.

Cracking the Code of Life

Part 14

A Family Disease



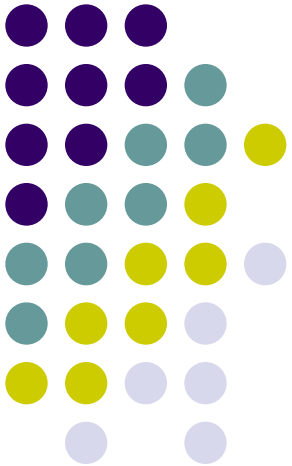
Polygenic Inheritance

- Polygenic traits are continuous traits governed by alleles at more than one genetic locus.
- Continuous traits show gradations, there is a series of measurable intermediate forms between two extremes.
- Skin color is a common example of a polygenic trait it is governed by 6 loci and at least 12 alleles.

Classical Genetics

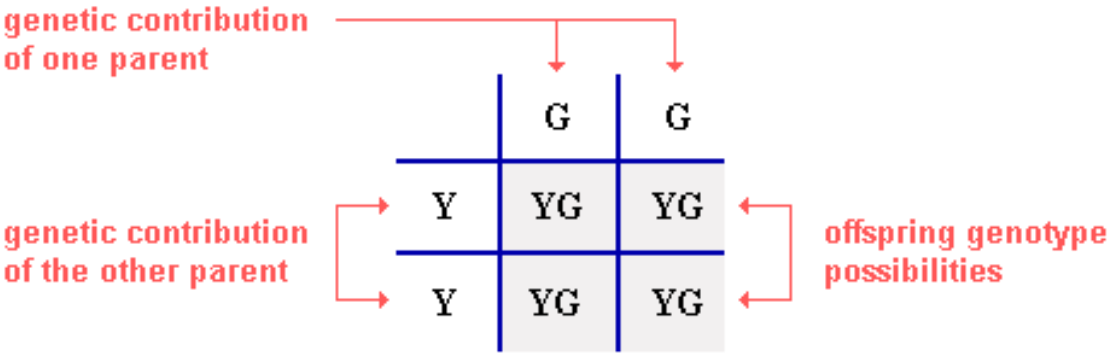
Animation 13:

Mendelian Laws Apply to Human Beings



Heredity and Evolution

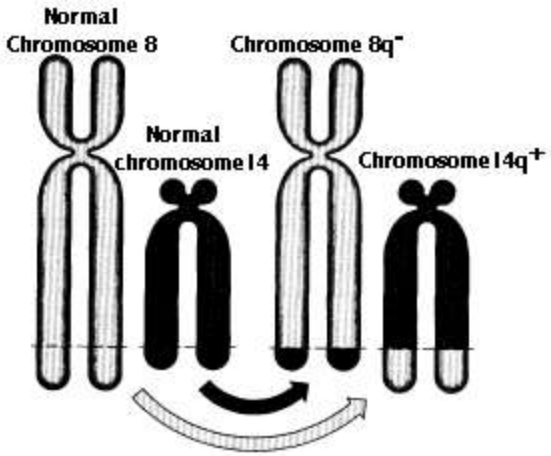
- Evolution works at four levels:
  - Molecular
  - Cellular
  - Individual
  - Population



- The levels reflect different aspects of evolution and are integrated in a way that produces evolutionary change.

Mutation and Evolution

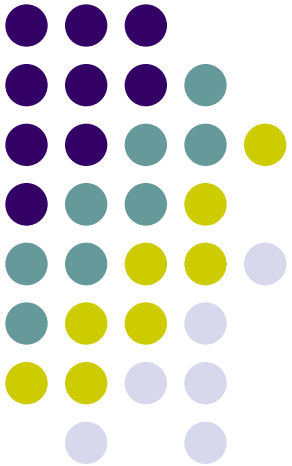
- Mutation is a molecular alteration in genetic material:
  - For a mutation to have evolutionary significance it must occur in a gamete (sex cell).
  - Such mutations will be carried on one of the individual's chromosomes.
  - During meiosis the chromosome carrying the mutation will assort giving a 50% chance of passing the allele to an offspring.



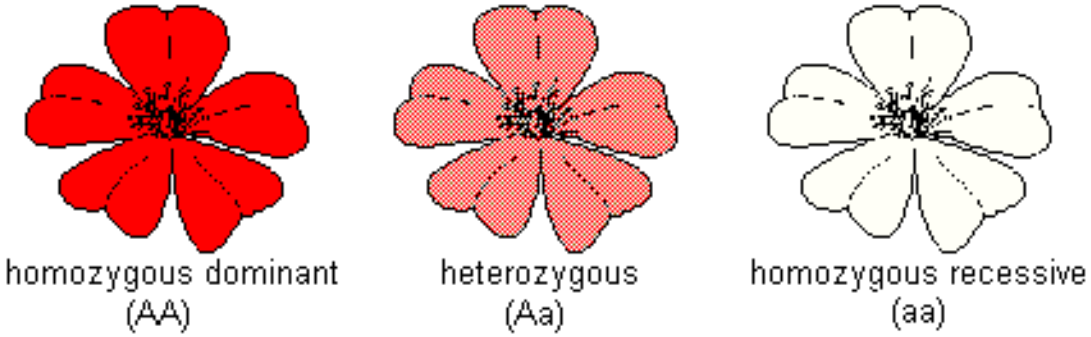
Mutation is a failure in gene repair.

A Mutation Story

A genetic mutation affecting the population of Africa



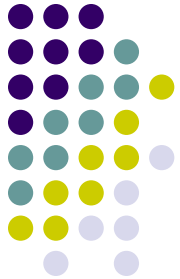
The Modern Synthesis



Evolution is a two-stage process:

1. The production and redistribution of variation (inherited differences between individuals).
2. Natural selection acting on this variation (whereby inherited differences, or variation, among individuals differentially affect their ability to reproduce successfully).

New Technologies

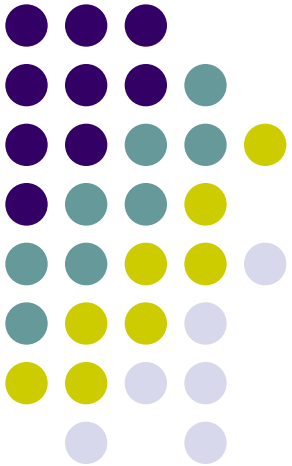


- Polymerase chain reaction (PCR) makes it possible to analyze and identify DNA as small as one molecule and produce multiple copies of the original DNA.
- Recombinant DNA techniques allow scientists to transfer genes from the cells of one species into the cells of another.
- Genetic manipulation is controversial due to safety and environmental concerns.

Cracking the Code of Life

Part 15

Genetic Modification



In-Class Groupwork

- Sit with 2 other people.
- Turn in one paper per group with everyone's names.

- Answer the following:

1. Explain the concepts of dominance, co-dominance, and recessiveness as used in modern genetics.

2. Explain how two parents who do NOT express a particular trait in their phenotype can nevertheless produce children who express the trait. Provide one example of a specific trait or disease where this could occur.

3. What is the effect of genetic bottlenecks on human and non-human species?