

REVISION: GENETICS & EVOLUTION

20 MARCH 2013

Lesson Description

In this lesson, we revise:

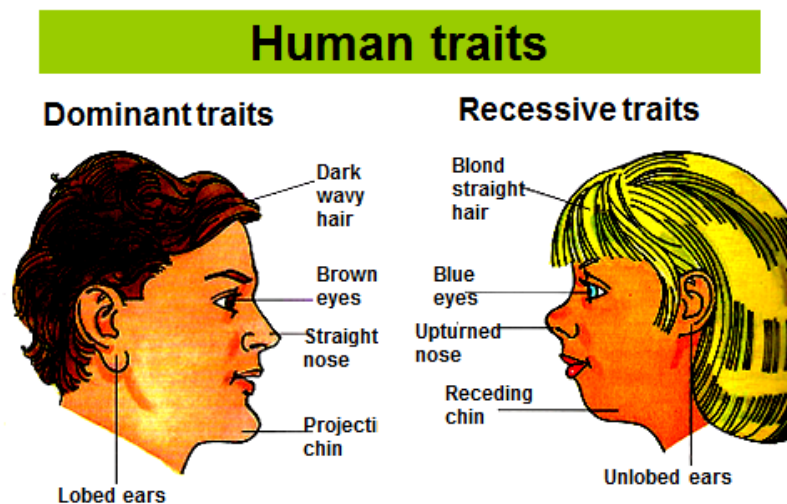
- The principles of Genetics including monohybrid crosses
- Sex linked traits and how to use a pedigree chart
- The terminology used and different theories of evolution

Key Concepts

What is Genetics?

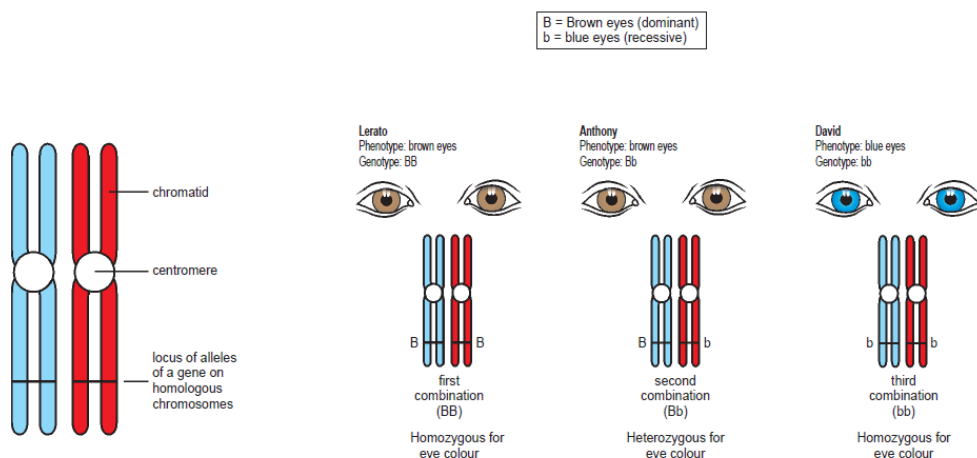
Genetics is the study of inheritance of characteristics

Some Characteristics in Humans



Terminology

Allele



(Life Sciences for all, Grade 12, MACMILLAN, Pg 247, Figure 5.21)

Homozygous and heterozygous

Genotype and phenotype

Dominant and recessive

Characteristic	Dominant traits	Recessive traits
eye colour	brown	blue
hair colour	dark hair	blonde hair
hairline	widow's peak	smooth hairline
lips	thick	thin
ears	earlobes free-hanging	earlobes attached
tongue	can roll tongue	cannot roll tongue

(Life Sciences for all, Grade 12, MACMILLAN, Pg 248)

Gregor Mendel - "Father of Genetics"



Austrian Monk.

Experimented with "pea plants".

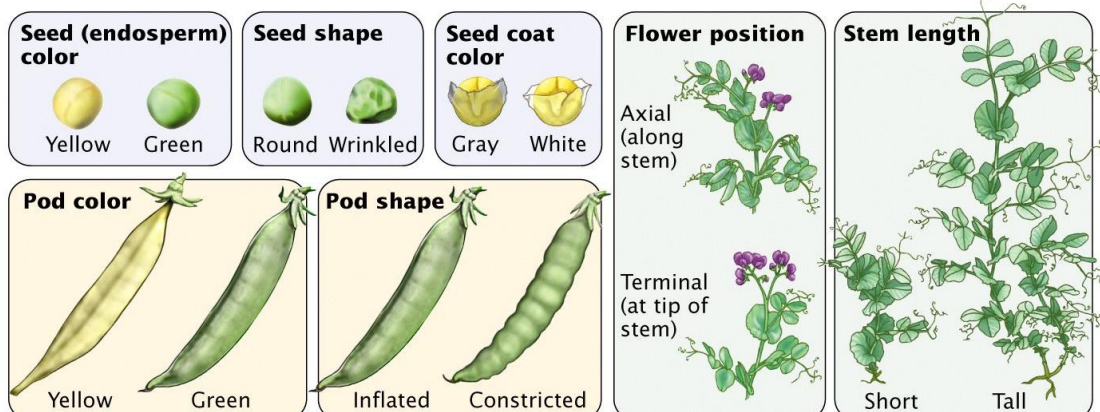
Understood that there was something that carried traits from one generation to the next- "FACTOR".

Worked with more than 28 000 plants. Why do scientists use such big samples?

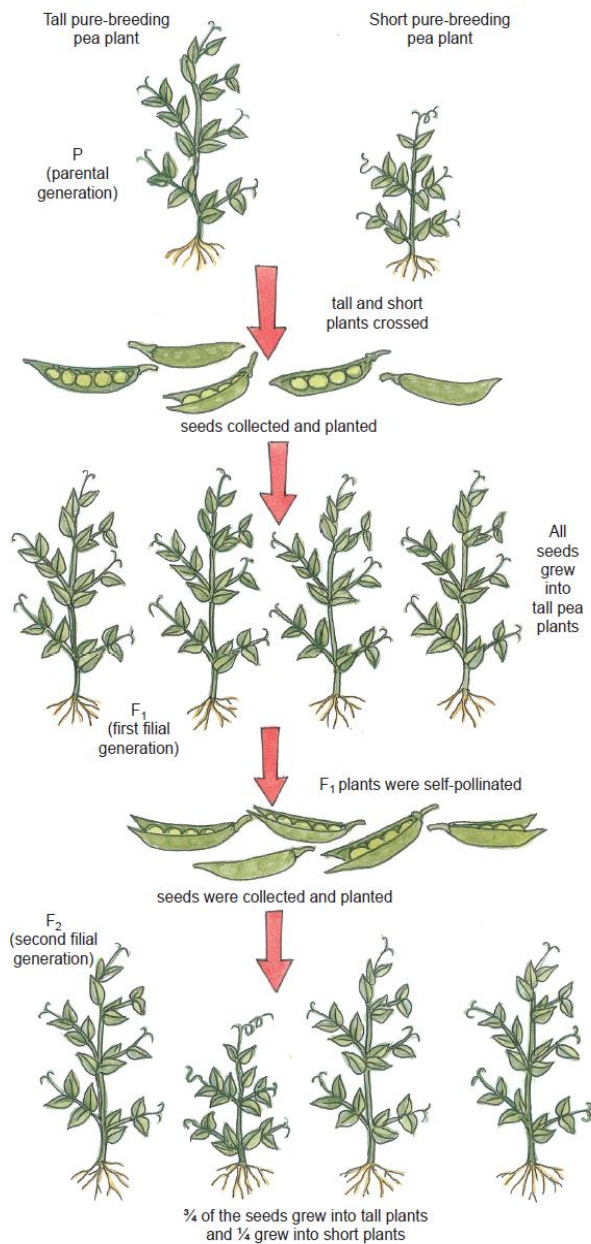
Why did he choose pea plants?

- Easy to cultivate
- Lots of progeny
- Pure-breeding strains are available
- They showed obvious differences in the traits
- Parentage can be controlled - Peas are self-fertilizing and can be crossed artificially

Mendel's Seven Characteristics



Monohybrid Crosses



Let T represent the allele for tall plants
Let t represent the allele for short plants

P (parental generation)

Phenotype
Genotype

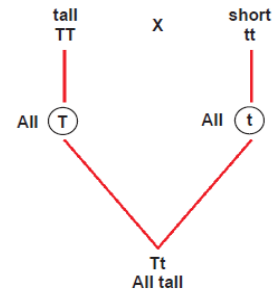
meiosis

Gametes

fertilisation

F₁ (first filial generation)

Genotype
Phenotype



Self fertilisations of F₁ pea plants

F₁

Phenotype
Genotype

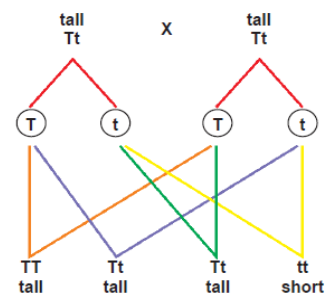
meiosis

Gametes

fertilisation

F₂ (second filial generation)

Genotypes
Phenotypes



This cross can also be written as a Punnett square

		Gametes of the other parent	
		T	t
Gametes of one parent	T	TT	Tt
	t	Tt	tt

Genotypic ratio = 1TT : 2Tt : 1tt
Phenotypic ratio = 3 tall : 1 short

A Punnett square can be used to predict the result of a genetic cross. It shows all the possible ways in which two types of alleles can combine to form the offspring, and all the possible genotypes of the offspring.

(Life Sciences for all, Grade 12, MACMILLAN, Pg 251, Figure 5.24 & 5.25)

By carrying out these monohybrid crosses, Mendel determined that the 2 alleles for each character segregate during gamete production. He thus formulated the **Law of Segregation**. Modern interpretation of the Law of Segregation: 'The characteristics of an organism are controlled by pairs of alleles which separate into different gametes as a result of meiosis. Therefore only one allele from each gene pair is present in a gamete.'

- The above example illustrates **COMPLETE DOMINANCE** - When two individuals with pure breeding (homozygous) contrasting characteristics are crossed, the F₁ generation all display the dominant characteristic.

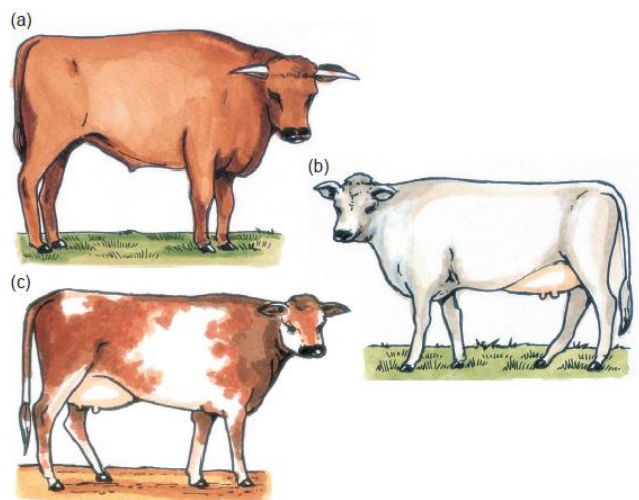
Not all characteristics follow in this pattern:

- Some show **INCOMPLETE DOMINANCE** - Neither allele is completely dominant over the other.



(Snapdragons showing incomplete dominance)

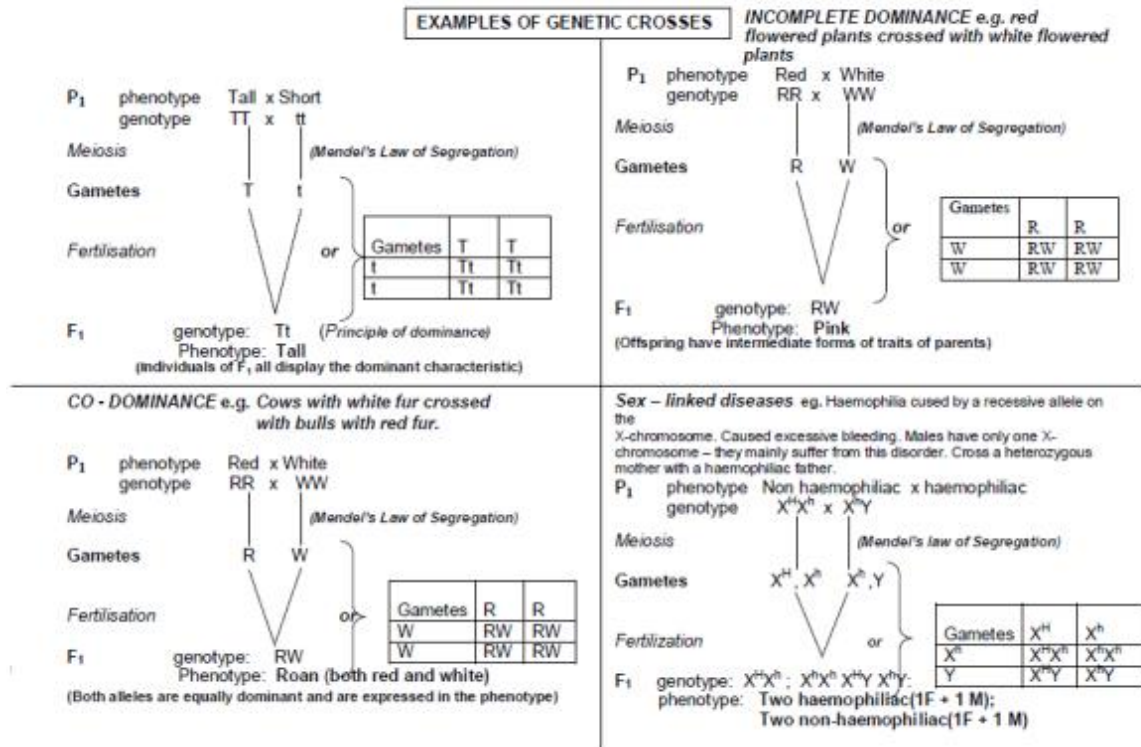
- Others display **CO-DOMINANCE** where genes have alleles that are **both expressed** in the heterozygote individuals



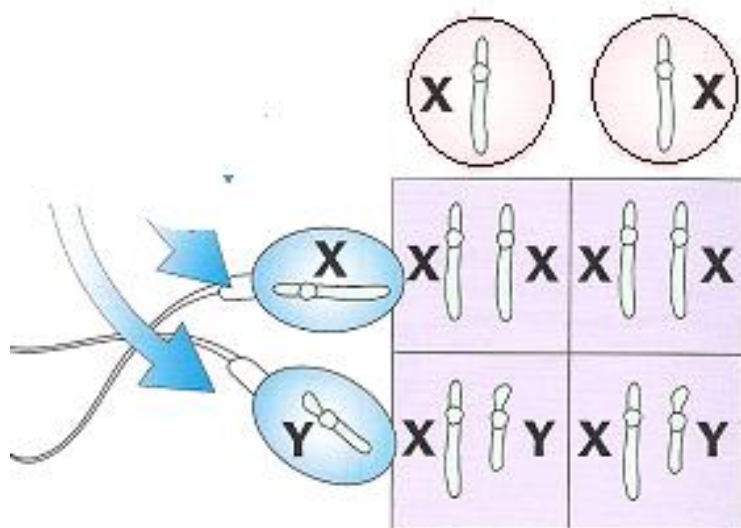
(Cows showing co-dominance)

Format for Genetic Crosses

(Use this whenever you have to solve a genetic problem)



How is Sex Determined in Humans?



Is it a boy or a girl?

Sex-linked Traits in Humans

- Sex-linked genes are genes on the sex chromosomes.
- Certain human disorders, like haemophilia, are caused by **sex-linked** genes.
- Y chromosome - much shorter than the X chromosome, only the X, and not the Y chromosome, carries the genes for these disorders.
- If a male inherits the recessive allele on an X chromosome from his mother, he will have haemophilia.
- If a female inherits the recessive allele, she would not have the disorder as long as her other X chromosome carried the normal, dominant allele of the gene.

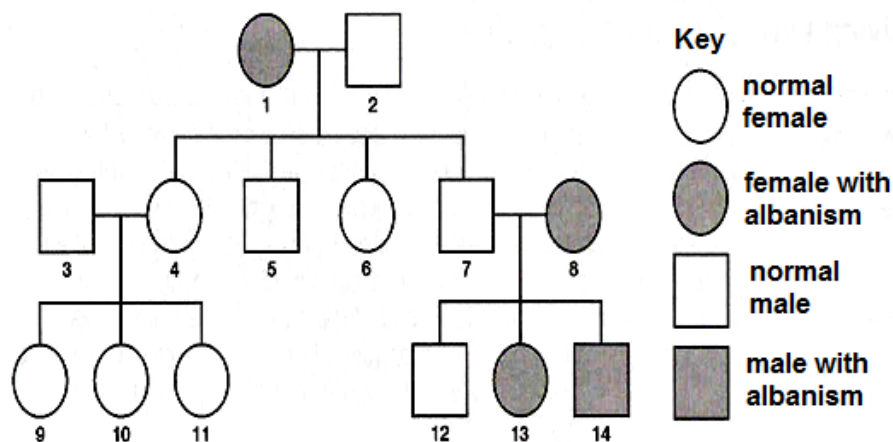
Genotypes	Description of phenotype
X^HY	Male with normal blood clotting time
X^hY	Male with haemophilia
X^HX^H	Homozygous female with normal blood clotting time
X^HX^h	Heterozygous female with normal blood clotting time, but carries the recessive allele
X^hX^h	Homozygous female with haemophilia

(From Life Sciences for All, Grade 12, Pg. 258)

Other mutations are autosomal – some are recessive while others are dominant.

What is a Pedigree Diagram?

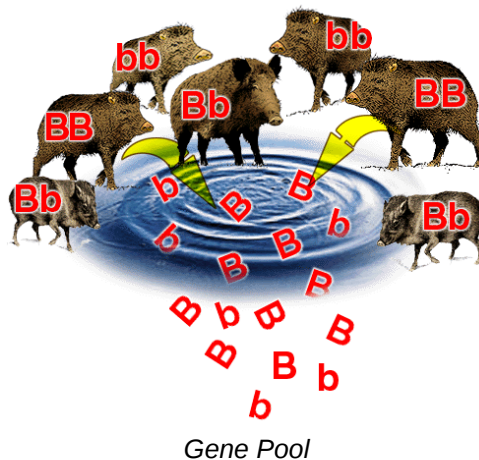
- Pedigree diagrams/charts are a way of graphically illustrating inheritance patterns over a number of generations
- Usually used to study the inheritance of genetic disorders



Key Concepts

Important Terminology

- Hypothesis:** A temporary explanation of physical phenomena, which can be tested by observation or experiment.
- Theory:** An explanation of a group of physical phenomena, firmly founded on observation and experiment, which continues on to be investigated.
- Evolution:** Evolve, to unroll, to disclose, to develop, to unravel.
The theory of evolution states that all species of living things that exist today (and many more which are now extinct) have evolved from simple life forms, which first developed more than 3 billion years ago.
- Gene pool:** The communal genes of all the organisms in a population at a particular time.



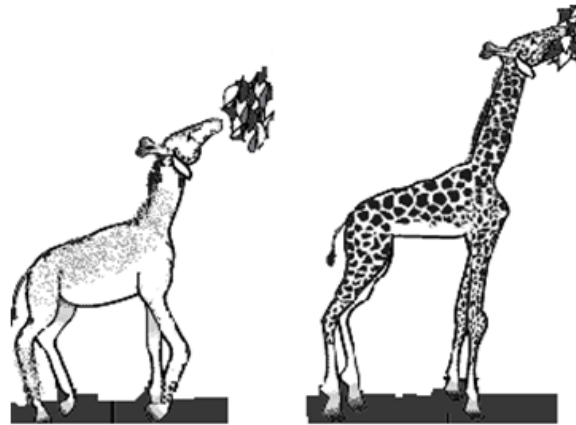
- Species:** A group of organisms that share similar characteristics and can interbreed and produce fertile offspring.
- Population:** A group of organisms of the same species that can interbreed in a specific habitat at a specific time

Questions

Question 1

Tens of thousands of years ago, the animals that evolved into giraffes were not as tall as modern giraffes. Over a long period of time, the necks of giraffes became longer. They could reach leaves high in the trees and reach down for water. (See diagram on next page)

- a.) Describe how the long necks of modern giraffes would have been explained by the following:
 - i. Darwin
 - ii. Lamarck
- b.) Explain why Lamarck's theory is not accepted.

**Ancestral Giraffe****Modern Giraffe****Ancestral and modern giraffes feeding****Question 2**

Both Darwin and Lamarck proposed theories to explain the origin of new species.

- a.) State the FOUR observations upon which Darwin based his theory. (4)
- b.) Tabulate TWO differences between Lamarck's and Darwin's theories. (5)

Question 3

Study the diagram of a duck's foot below.

*Webbed foot of a duck*

Ancestors of ducks did not have webbed feet. Explain how the webbed feet could have evolved in terms of natural selection. (5)

Question 4

(Adapted from November 2012, P1, Question 4)

One of the observations Darwin made during his study of pigeons was about artificial selection. In 1859 Darwin and Wallace jointly proposed that new species could develop by a process of natural selection.

Using examples describe natural and artificial selection and also highlight the differences between these two processes.

Content: (17)

Synthesis: (3)

(20)