

# Program Script

## Mendelian Genetics

### *The blueprint of life in action*

In the 19<sup>th</sup> Century, Gregor Mendel was able to work out the basic laws of genetics by studying the garden pea.

So how does the garden pea reproduce?

Each flower has five sepals with almost completely cover the stamens.

The ten stamens reach around the stigma. When the ripe stamens burst open, the pollen lands directly on the stigma, which has a brush-like surface.

The pollen germinates, and grows through the pistil to the ovary.

The pollen fertilises the egg cells - four to ten seeds are formed.

The garden pea is a self pollinating plant. That is, it contains both the male and female sex cells, and can reproduce without another plant. The ripe fruit of the garden pea is called a pod. For cross-breeding experiments, the buds are artificially pollinated.

Some of the sepals are removed with very fine scissors.

The bud is not yet ripe, which means that its stamen is not producing pollen. Therefore the plant is unable to pollinate itself.

The stamens are cut off very carefully, without damaging the stem.

Now the stigma is pollinated with pollen from a different pea-plant. This process is called cross-pollination.

### *The Law of Segregation*

In this field, two different types of peas are grown. One type only has round seeds, and the other type has wrinkled seeds. Mendel ensured that the parental plants were purebred by allowing each variety to self-pollinate for two years.

In order to cross these breeds, first we have to plant the seeds and wait for them to grow. These plants are the parental or P-generation.

Their buds are cross-pollinated. The pollen from one type is placed on the stigma of the other.

Here the parental generation, P1 is already bearing fruit. Its seeds are the 1st filial generation, or F1.

Even though they originate from one parent plant with round seeds, and one parent plant with wrinkled seeds, all of the seeds are round.

This diagram shows the outcome once more.

If we cross-pollinate two pea plants with different traits for a specific characteristic, the hybrid offspring are all the same in that characteristic.

The characteristics of living things are controlled by hereditary units called genes. Genes for the same characteristic, called alleles, occur in pairs. In the sex cells however, only one of each allele is present. This is the law of segregation.

The allele for round is here called capital R and the allele for wrinkled is small r. The parental generation, P1, is purebred - this means that both its alleles are identical.

The sex cell, or gamete, contains each allele only once.

During fertilisation the gametes fuse into one another.

The seeds from the F1-generation contain two different alleles, they are crossbred. Their appearance however is round. The two alleles have a different influence on the appearance.

The allele capital-R determines the shape of the seed – it is dominant. The allele small-r is not distinct, it is recessive. So all of the peas in the F1 generation are round.

The seeds from the last cross-breeding, filial generation F1, are sown and reared into plants. Then the plants are crossed again.

The seeds from the F1 generation plants are called F2.

What shape will the seeds have?

Even though the peas in F1 were all round, some of the F2 seeds are round, and some are wrinkled.

But what is the ratio between the two shapes of seeds?

The peas are sorted. There are more round seeds than wrinkled ones.

If we do enough cross-breeding – in his experiments Mendel sorted 8021 peas – we come to the following results: The ratio between the round and the wrinkled seeds is 3 to 1.

Let's summarise: In the parental generation, P, two purebred plants were cross pollinated.

Seeds of their hybrid offspring, F1, were all round.

When we crossbreed these seeds we have generation F2. The seeds of these plants were round and wrinkled in the ratio of 3 to 1.

The law of segregation states that the characteristics of living things are controlled by hereditary units called genes. Genes for the same characteristic, called alleles, occur in pairs. In the sex cells however, only one of each allele is present.

The allele for round is here capital R and the allele for wrinkled is small r. The parental generation is purebred, which means that both the alleles are identical.

The sex cells contain only one copy of each allele.

During fertilisation the various germ cells merge into one another.

The seeds from the F1-generation contain two different alleles, they are crossbred. However they appear round. Both alleles have a different influence on the appearance.

The capital-R allele determines the shape of the seed, it is dominant. The small-r allele is recessive.

The sex cells of the F1-generation contain either the capital-R allele or the small-r allele. When they merge into the filial generation F2, the following combinations occur.

Purebred round

crossbred round

crossbred round

and purebred wrinkled.

And that is why the characteristics of the parental generation appear again in the F2-generation at a ratio of 3 to 1.

### ***The Law of Independent Assortment***

These two types of garden peas are purebred. One type contains gold wrinkled seeds, and the other green round seeds.

They are planted.

The plants grown from these seeds are the parental generation, P.

The two types of the parental generation are cross-pollinated.

Their seeds are filial generation F1.

They are all gold and round.

These gold round seeds too were grown into plants and cross-pollinated.

Their seeds are the filial generation F2. What colour and shape will these have?

A few pods are opened.

All four combinations of shape and colour appear here.

What are their ratios?

To increase the reliability of our results, we need a large number of these peas - Mendel sorted 556.

The combination of characteristics stands in the ratio of 9 to 3 to 3 to 1.

How can we explain this? The parental generation, P, is green round and gold wrinkled. It is purebred for the shape and colour of its seeds. The allele for a round shaped pea is marked with a capital-R and the allele for a wrinkled pea is small-r, small-g stands for the seed colour green and capital-G for gold.

The sex cells contain only one allele for shape and one for colour.

During fertilisation they fuse into the F1-generation. The peas in this generation are gold and round, because the corresponding alleles are dominant.

The F1-generation is crossbred in its shape and colour of seeds.

The characteristics for shape and colour are inherited separately - that's why it is able to form four different types of sex cells. This is called the law of independent assortment.

These alleles are fused in the F2-generation – creating the following combinations.

The F2-generation can be purebred for round and gold,

purebred for round and green

purebred for wrinkled and gold

and purebred for wrinkled and green.

All other combinations lead to crossbred peas with the corresponding appearances.