

Polygenic Inheritance

Introduction

One major problem in genetics during the early 20th century involved the following question. "If Mendel's ideas were correct then how can we explain the inheritance of traits where the offspring of a cross tended to be intermediate in appearance between the two parents?"

For instance if one parent is tall and the other short, the offspring tend to be intermediate in height. In other words, the offspring in a cross tend to be a blend of both parents, and not a 3: 1 ratio of Tall to Short children, as Mendel found in peas.

Inheritance like this was first suggested by Kolreuter in 1760 and called "polygenic inheritance". It was not proven experimentally until 1908 by Nilson-Ehle. It is interesting to note that polygenic inheritance in humans was first studied by Mendel's cousin, Francis Galton, in 1883.

Assumptions of the polygenic model of inheritance:

This model makes the following 6 simplifying assumptions:

- Each contributing gene has small and relatively equal effects.
- The effects of each allele are additive.
- The genes at each locus behave as if they follow Codominance.
- There is no linkage involved.
- The value of the trait depends solely on genetics; environmental influences can be ignored .

Example; Polygenic inheritance of colour in wheat.

Kernal colour in wheat is determined by two gene pairs that produce a range of colours from white to dark red depending on the combinations of alleles. Dark red plants are homozygous AABB and white plants are homozygous aabb. When these homozygotes are crossed the F1 offspring are all double heterozygotes AaBb. Thus crossing individuals with the phenotype extremes yield offspring that are a 'blend' of the two parents.



This illustrates an important point that many times when you have two parents who differ in phenotype for some characteristic, there is a tendency for the offspring to be intermediate to the parents in phenotype.

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But what happens when the two double heterozygotes (AaBb) are crossed?

The results are shown in the following Punnett Square

Notice the 5 phenotypes - the number of upper case alleles 0 to 4 possible in the offspring.

Observe too that even though both parents are intermediate, there is not blending in the offspring.

Offspring can be more extreme than either parent- 1/16th of the offspring are dark red.

Even though the polygenic model makes a number of simplifying assumptions it does seem to be a good approximation to the inheritance of a large number of traits which show continuous variation.

	AB	Ab	aB	ab
AB	AABB	AABb	AaBB	AaBb
Ab	AABb	AAbb	AaBb	Aabb
aB	AaBB	AaBb	aaBB	aaBb
ab	AaBb	Aabb	aaBb	aabb

Questions

1. Which Gene A or B is dominant?
2. Put these genotypes in order of darkness: AAbb , AaBB , AABB , aaBb.
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3. How many different colours (Phenotypes) are there?
4. Sketch a bar chart to show the 1: 4: 6: 4 :1 ratio of phenotypes

5. Explain how the existence of multiple **genes** controlling skin colour can result in the appearance of many different shades of skin colour in humans?

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