Methods for Working Problems

We pause here for a few words on the working of problems. The Punnett square is sure and graphic, but it is unwieldy; it is suited only for illustration, not for efficient calculation.

A branch diagram is useful for solving some problems. For example, the 9:3:3:1 ratio can be derived by drawing a branch diagram and applying the product rule to determine the frequencies. (Note the use of the convention that *R*– represents both *RR* and *Rr*. That is, either allele can occupy the space indicated by the dash.)

$Rr\,Yy \times Rr\,Yy$

F_2 → 3/4 round $(R-)$
- → 3/4 of these will be yellow $(Y-)$ → 9/16 round, yellow $(R-\,Y-)$
- → 1/4 of these will be green (yy) → 3/16 round, green $(R-\,yy)$

F_2 → 1/4 wrinkled (rr)
- → 3/4 of these will be yellow $(Y-)$ → 3/16 wrinkled, yellow $(rr\,Y-)$
- → 1/4 of these will be green (yy) → 1/16 wrinkled, green $(rr\,yy)$

The diagram can be extended to a trihybrid ratio (such as $Aa\,Bb\,Cc \times Aa\,Bb\,Cc$) by drawing another set of branches on the end. However, as the number of gene pairs increases, the number of identifiable phenotypes rises startlingly, and the number of genotypes climbs even more steeply (Table 2-3). With such large class numbers, even the branch method becomes unwieldy.

In such cases, one must resort to devices based directly on the product and sum rules. For example, what proportion of progeny from the cross $Aa\,Bb\,Cc\,Dd\,Ee\,Ff \times Aa\,Bb\,Cc\,Dd\,Ee\,Ff$ will be $AA\,bb\,Cc\,DD\,ee\,Ff$? The answer is easily obtained if the gene pairs all assort independently, thereby allowing use of the product rule. That is, 1/4 of the progeny will be *AA*, 1/4 will be *bb*, 1/2 will be *Cc*, 1/4 will be *DD*, 1/4 will be *ee*, and 1/2 will be *Ff*, and so we obtain the answer by multiplying these frequencies:

$$p(AA\,bb\,Cc\,DD\,ee\,Ff) = 1/4 \times 1/4 \times 1/2 \times 1/4 \times 1/4 \times 1/2 = 1/1024$$

Table 2-3. Rise in number of genotypic classes as the power of the number of segregating gene pairs

Number of segregating gene pairs	Number of phenotypic classes	Number of genotypic classes
1	2	3
2	4	9
3	8	27
4	16	81
⋮	⋮	⋮
n	2^n	3^n