2. How Many Functional Molecules?

Discussion of question raised in *Resonance* Vol.2, No.7.

The biochemist is correct in the first part of the answer. Three types of molecules will be produced. We cannot differentiate between D-N and N-D. After that, however, he makes a mistake which is too common among non-mathematicians. The fact that there are n possible events is not sufficient to infer that the probability of each is $1/n$. The presence of three types of molecules does not necessarily mean that all are equally abundant.

The mathematician starts with the assumption that the association of two polypeptides is random. If you pick up one polypeptide randomly, let the probability that it is normal be p and defective be q. Here, since the rates of synthesis of the normal and the defective polypeptide are assumed to be equal, we can say that $p = q = 0.5$. Now we can ask the question, what is the probability that two consecutively picked up polypetides turn out to be normal ? It will be $p \times p$ or p^2. It turns out to be 0.25 or one-fourth, and for that of both being defective it will be $q^2 = 0.25$. The probability of picking up a N followed by D will be $p \times q$. Likewise, for D followed by N, it will be $q \times p$. Since we are unable to differentiate whether it was N-D or D-N, both being possible, we will add these two to get $2 \times p \times q = 0.5$. Thus half of the proteins will have one normal and one defective polypeptide. Write the three in sequence — $p^2 + 2pq + q^2$. You will immediately realise that it is $(p + q)^2$. This binomial expansion is extremely important in both population and molecular genetics.

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> Science consists in grouping facts so that general laws or conclusions may be drawn from them.
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> *Charles Darwin*