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Genetic Interaction

The accumulation of biological data, notably from the Human Genome Project, has created an impetus to study complex biological systems as wholes, instead of individual genes and proteins as in the past three decades. In this new "system" framework, scientists are less concerned with the properties of a gene in isolation than with its function within a system. One way to gain understanding in the relationships between genes is to study *genetic interactions*.

A genetic interaction is a functional link between two genes: for example, if deleting a gene A from the genome of an organism doesn't affect its viability, deleting a gene B neither, but deleting both causes death, there is a genetic interaction (so called *synthetic lethal*) between the genes A and B.

As an analogy, we can consider the following scenario. Alyssa and Ben work in the same organization. If either Alyssa or Ben left and the other stayed, the organization would survive; if both left, the organization would die (go bankrupt). A few hypotheses could account for this "personnel" interaction. If Alyssa and Ben were part of the same essential department, it would mean that the department could compensate for one absence but not for two. That is, in the simplest case, Alyssa and Ben might be able to substitute for one another. It could be more complicated however: Chris, a third employer, might be able to replace either Alyssa or Ben but not both at the same time. If Alyssa and Ben were in distinct departments, the explanations would simply shift to a higher level: their departments could substitute for one another or, more generally, the organization could survive with one of these departments malfunctioning but not both.

In our biological systems, the same explanations hold with "gene" instead of "person", "process" instead of "department" and "organism" instead of "organization". Briefly then, there are two kinds of explanations: genes A and B are part of the same essential process, which can somewhat compensate for one deletion; genes A and B are essential parts of parallel processes, of which only one is needed for the organism's viability.

One aspect that is simpler in our biological system than in our organization analogy is that we can actually model what "substitute" or "compensate" for one another means. Thus, through our models, we can identify these possible "substitutions" or "compensations" in order to better understand how genes interact with each other.

The study of genetic interactions is a little step towards a future where diseases will not be cured by trial-and-error and luck but by a systematic approach in drug discovery.