The Immune System and Bodily Defence

1. Why Do We Need an Immune System?

How does the human body defend itself, and why does it choose the paths it does choose?

How is the Immune System Peculiar?

The immune system is unusual among physiological systems in many respects. Each individual peculiarity may be shared, perhaps, with others, but together, these characteristics make the immune system distinctly different from its fellow systems. One, it is not an anatomically well-localized and circumscribed set of organs. Two, it is resting in the ideal state and must be called upon before it becomes active. Three, even after being triggered to function, it has to undergo cellular maturation before it can be effective. Four, apart from the reproductive organs, it is perhaps the only system in which component cells rearrange their DNA and even lose large portions as a necessary step during development and maturation.

Why does the immune system behave so peculiarly in so many ways? Like good Darwinians, let us try to derive all these peculiarities from requirements imposed by the functional demands on the immune system. So the first question that arises is - why is the immune system necessary?

Why is the Immune System Necessary?

To answer this, consider what an organism that has chosen true multicellularity has to do. It has to keep its component cells together, and it has to get different groups of them to perform different functions. This commitment to division of labour means that every cell of the body cannot do everything. Some
Metazoan life necessitates some form of defence against many kinds of invasion. Cells may become so specialized that they cannot survive as free-living entities. Many such cell types will therefore have to be provided with readymade essentials of life. For this, the body has to maintain a rigidly controlled internal environment that is rich in nutrients. This is an invitation to all sorts of creatures from outside to come in and feed off the bonanza. If the host organism is to maintain its integrity, it must be able to get rid of these freeloding invaders.

In fact, it is even possible that a cell of the host organism may escape the control of the organism and take off on its own on an autonomous lifestyle, using the controlled internal environment and the nutrients available in it to make hay. This is what we commonly call a malignant or cancerous cell. Such aberrant cells also have to be dealt with. In other words, metazoan life necessitates some form of defence against many kinds of invasion.

Experimentally, one can ask the question - what is the immune system good for? - by looking at animals that do not have immune systems, either through spontaneous defects such as genetic immunodeficiencies, or engineered defects such as in mice which have had some gene critical for immune function deleted. In most respects, such 'immunodeficient' animals may appear to be quite normal, healthy and happy insofar as can be determined. They do not suffer particularly from any increased frequency of cancers either, which suggests that the evolution of the immune system is unlikely to be driven strongly by the occurrence of cancerous transformations, and estimates of the low frequency of normal spontaneous rates of mutation during DNA replication, which are of the order of one in ten million, would help explain why mutation-derived cancers are not a major evolutionary pressure for the immune system.

However, such immune-deficient animals do fall ill very readily with a variety of infections, and in fact, they tend to die very quickly if exposed to even so-called normal external environments which are, of course, teeming with potential freeloaders.