

multiply until it has increased a million-fold the quantity of protoplasm which it originally possessed, in this way building up the matter of life, to an indefinite extent, from the *common matter* of the universe.

No matter under what guise it takes refuge, whether fungus or oak, worm or man, living protoplasm not only ultimately dies and is resolved into its mineral and lifeless constituents, but it is always dying, and strange as the paradox may sound, could not live *unless* it died.

Notwithstanding all the fundamental resemblances which exist between the powers of protoplasm in plants and animals, they present a striking difference, in the fact that plants can manufacture fresh protoplasm out of minerals and mineral compounds, whereas animals are obliged to procure it ready-made, and hence, in the long-run, depend upon plants for their supply. At the present time we may look upon protoplasm as the basis of physical life in the same sense that some form of it is the essential and active constituent of every living cell or tissue, whether vegetable or animal, and that it is only formed through the physiological activities of living organisms. In the absence of life, protoplasm cannot be formed, and, so far as we can perceive, there are no manifestations of life without it.

Living substance or protoplasm must be looked upon as constantly undergoing changes that vary with the functions required of it. These changes, without attempting to distinguish between them, as chemical, physical, or more strictly speaking, biological, are most conveniently expressed by the general term metabolism, which is both constructive and destructive.

Dr. M. Foster says: "We may picture to ourselves this total change, which we designate by the term metabolism, as consisting, on the one hand, of a downward series of changes (katabolic changes), a stair of many steps, in which more complex bodies are broken down into simpler and simpler waste bodies, and on the other hand, of an upward series of changes (anabolic changes), as also a stair of many steps, by which the dead food, of varying simplicity and complexity, is, with the further assumption of energy, built up into more and more complex bodies. The summit of this stair we call protoplasm."

All work implies waste, and the work of life results, directly or indirectly, in the waste of protoplasm. Every word uttered by a speaker costs him some physical loss, and, in the strictest sense, he burns that his hearers may have light—so much of his body resolved into carbonic acid and urea.* It is one of the funda-

* It is said that urea circulates in the blood, and is excreted by the kidneys, and the more mental work the more urea is produced. A fretfulness that produces activity, but no actual results, causes a loss of just so many grains of urea. Therefore, for every footpound of thought you will have a given amount of urea excreted.