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Plant cell biology: intracellular protein transport

In plant cells, energy transduction takes place in two specialised organelles (compartments in the cell enclosed by biological membranes), the mitochon¬drion and the chloroplast. In the chloroplast, solar energy is stored as chemical energy in a process called photosynthesis.

This process is unique for plants, algae and photosynthetic bacteria. In the mitochondrion, the cellular respiration takes place. In this process, common to both animals and plants, energy is recovered when energy-rich compounds (carbohydrates and fats) are degraded. Both photosynthesis and cellular respiration are complicated processes, which can be divided into many partial reactions. Despite the fact that photosynthesis may appear as the opposite of cellular respiration, the two processes do in fact share many similarities. One important similarity is that many of the enzymes involved are membrane proteins, integral components of biological membranes.

Most of the proteins in the organelles are synthesised outside the organelle and must be transported into it. They are synthesised with an extension called presequence, which functions as an ”address tag”. This tag is recognised by receptors on the surface of the organelle, and thereafter the protein is transported into the organelle. In plant cells, which have both chloroplasts and mitochondria, this process is more complicated than in animal cells. The presequences directing proteins to mitochondria and chloroplast are similar, but there are small differences that determine to which organelle the protein is directed.

We study the structure of these address tags, and how they are able to direct a protein to chloroplasts or mitochondria and also further within the organelle. As experimental organisms, we use higher plants, mostly pea and wheat, and the unicellular alga Chlamydomonas.

To map the mechanisms that regulate the transport of proteins to and within chloroplasts and mitochondria, we use isolated DNA clones encoding specific chloroplastic and mitochondrial proteins. Using the DNA clones as templates, we produce radioactively labelled proteins. These labelled proteins are mixed with isolated chloroplasts or mitochondria, or with purified membrane fractions. In this way, we can study the molecular mechanisms of protein/membrane interactions. To study protein transport directly in living cells, a hybrid gene with a modified sorting signal has been constructed. When this gene is introduced in algal cells we will be able to compare the sorting of the modified protein and the original protein in the cells.

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