

Oxygen produced by isolated chloroplasts

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1. INTRODUCTION

The system concerned with the assimilation of carbon dioxide by the green plant has, under optimum conditions, an activity comparable with the highest rate of cellular respiration in animals. At the moment there is, in the case of animals, considerable knowledge of the subcellular* chemical mechanisms which can be connected with respiratory activity. In the green plant, on the other hand, there is still no direct indication of a single chemical mechanism connected with carbon assimilation. As the oxygen uptake of tissue preparations apart from CO₂ evolution is a guide in searching for systems connected with respiration, so might an oxygen output, apart from CO₂ absorption, indicate mechanisms characteristic of photosynthetic activity in the plant. The subcellular evolution of oxygen under illumination has been known in the case of green plants for many years (Spoehr 1926). The effect, however, was always insignificant compared with the original photosynthetic activity of the cell. The oxygen could only be detected by using certain bacteria which show either motility or luminescence with traces of this gas. But to this method we owe the classical investigations of Engelmann (Spoehr 1926) who showed that in the living cell oxygen appeared in the neighbourhood of the illuminated chloroplast and the experiments on the isolated chloroplasts of *Funaria hygrometrica* by Haberlandt, who demonstrated the production of oxygen in light. Ewart (1896) confirmed and extended these results using other mosses and *Selaginella helvetica*; in a phanerogam, *Elodea*, no oxygen could be observed to come from the isolated chloroplasts.

The same problem was approached in a somewhat different manner by Molisch (1925). The leaves of many phanerogams were allowed to dry

* The term *subcellular* is used here to imply a degree of organization less than that of the whole cell.

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SUMMARY

1. Haemoglobin has been used in a spectroscopic method of measuring both the appearance and disappearance of small quantities of oxygen.
2. Cell-free suspensions of chloroplasts have been obtained from the leaves of various angiosperms by grinding in isotonic sucrose solutions.
3. The observations of earlier workers, that chloroplasts will produce molecular oxygen apart from the living cell, have been confirmed by an independent method, and the quantities of oxygen evolved under different conditions have been measured.
4. The chloroplasts after removal from the cells only evolve oxygen in light when in the presence of extracts of leaves or certain ferric salts, and do not evolve oxygen from carbon dioxide.
5. In particular the chloroplasts will cause a photoreduction of ferric oxalate to ferrous oxalate and oxygen; the oxygen obtained corresponds to the iron reduced.
6. The illuminated chloroplasts in the presence of leaf extracts evolved oxygen up to a pressure of 1 mm. mercury; in the presence of ferric oxalate a pressure of 4 mm. of mercury can be reached.
7. It is concluded that a system can be removed from the cell of a green plant which will convert light energy into a measurable amount of chemical work. That molecular oxygen is produced in these circumstances, places the system in a category unique among other chemical systems.