There appears to be little hope that the efficiency of the photosynthetic process can be increased by selection or breeding.

On the basis of this information, Prof. Gregory considered the most effective methods of utilizing plant growth for storing solar energy. The most convenient product would be sugar or starch in the form of stored products in tubers or roots, which would be readily convertible to alcohol by fermentation processes. Prof. Gregory mentioned schemes which have been suggested for using micro-organisms, such as the green alga *Chlorella*, for the building up of chemical energy, and pointed out that there are so many difficulties that the use of higher plants with storage organs would appear more economical.

R. Long

FUNCTIONS OF THE SKIN OF VERTEBRATES

SECTIONS D (Zoology) and I (Physiology) of the British Association joined forces on the morning of September 1 to hear a group of papers on the functions of the skin.

Prof. P. B. Medawar (Birmingham) opened the session by discussing the anatomy of the mammalian epidermis, referring specially to the anatomical basis of pigmentary activity. He said that standard text-book diagrams of transverse sections of the skin are almost invariably at fault in their complete omission of the cells responsible for melanin formation—the cells variously called dendritic cells or epidermal melanoblasts or melanophores. Dendritic cells form a distinct lineage in the epidermis, and, as American work has shown, arise in development from the neural crest. The dendritic cell is the sole origin and seat of pigmentary function in the epidermis. In some manner the melanin formed within it is caused to enter into the cytoplasm of the Malpighian cells on which its branches end, a peculiar mode of secretion which Masson has called 'cytocrine'. Studies of whole mounts of pure epidermal sheets, treated with Methylene Blue or the Dopa reagent, reveal the shape, number and distribution of dendritic cells with conspicuous clarity. In particular, they reveal that dendritic cells, which are so distributed in the basal layer as to lie at arms' length from each other, often anastomose to form local syncytia.

Prof. Medawar recalled R. E. Billingham's demonstration that white and negro skins resemble each other in the number, form and distribution of their dendritic cells. The difference between them is merely functional: the dendritic cell of negro skin maintains the higher level of pigmentary activity. The same is true of the difference between red and black skin areas in patched guinea pigs.

In conclusion, Prof. Medawar asked for a revision of text-book diagrams of the anatomy of the epidermis, and said that British dermatologists might well revise, or at least reconsider, the histopathology of skin in the light of this newer knowledge of its anatomy.

Dr. J. D. Findlay and Mr. W. R. Beakley (Hannah Dairy Research Institute, Ayr) reported work which throws quite a new light on the problem of temperature regulation in cattle. Dr. Findlay put the question whether cows sweat—indeed, whether they have sweat glands at all. Deep in the dermis of cows' skin lie large, poorly vascularized, sac-like glands lined with myo-epithelial cells which pass a colloid secretion through ducts on to the skin surface[1]. These are commonly called sweat glands; but there is no evidence that they are instruments of temperature control.

The climatological room at the Hannah Institute was described by Dr. Findlay. The room was designed to study the mode of heat loss in cattle. It can be kept at any temperature between 20° and 60° C., and at almost any humidity, with or without air movement; and suitable instrumentation makes it possible to keep a continuous record of the respiration-rate, heart-rate and skin-temperature of the calves kept in it. It has been shown that, at a constant saturation deficit, the skin-temperature rises in direct proportion to the temperature of the environment: there is no flattening or drop at any level to suggest that sweating has begun. Peripheral vasodilatation in calf skin is probably already at maximum at 20°. Moreover, injections of pilocarpine or adrenaline, which provoke sweating in horses, have no such effect on calves.

Presumably, then, said Dr. Findlay, the cow loses heat from the skin primarily by radiation—unlike the horse, but probably like the dog and sheep. The cow is therefore not well adapted to tropical climates; but, as Bonsma has shown, the cow best adapted as a radiator of heat is one with a glossy coat of light colour bearing short hairs with pigmented tips. It is noteworthy that tropical cattle like the zebu have the same skin structure as those from more temperate climates. One reason for their superior heat tolerance is probably the very large dewlap which, since it has a particularly dense network of capillaries immediately below the skin surface, is probably an efficient extra radiator of heat.

Dr. W. S. Bullough (Sheffield) described his work on the replacement of the epidermis. Just as hairs might be replaced continuously, as in sheep, periodically, as in rats and mice, or seasonally, as in wild mammals, so the replacement of the epidermal layer is not a continuous and uniform process. There are recognizable patterns of replacement in space (for example, the anterior-posterior gradient of cell-division frequency in the skin of the mouse's back) and rhythms of replacement in time. All mice show a daily rhythm, and in female mice a rhythm in step with the œstrous cycle is superimposed on it.

Mitotic activity is high during natural or artificially induced sleep or at rest, and muscular activity is probably responsible for its fall by day. Injections of glucose or of phosphate before sleep raise the rate of cell division, and injections of phlorizin lower it. The blood-sugar level falls during rest, but significant quantities of glycogen are deposited in the skin as well as in the liver, and the rate of cell division at once rises. The facts, said Dr. Bullough, suggest that glycogen is the energy source that controls rate of cell division. It is noteworthy that although skin cultured *in vitro* in the absence of oxygen shows no new cell divisions, those started pass to completion. Oxygen, glycogen and phosphate all seem to act in advance of visible prophase—perhaps in an 'antephase' as little as fifteen minutes beforehand.

The general rise of mitotic activity during œstrus in female mice is no less conspicuous in the epidermis than elsewhere. Dr. Bullough suggested that œstrogen acts both directly, in influencing the frequency and completion-time of mitosis, and, indirectly, by mobilizing glycogen and causing its deposition in the epidermis, and by dilating the capillaries and perhaps increasing their permeability. The abundance of œstrogen in plants hints at the possibility that it exerts a very widespread action as a controller of mitosis.

Dr. Bullough ended by saying that a study of mitotic frequency has obvious practical bearings. Lowering the food intake of mice by one-third depresses the rate of cell division, and is known to prolong their life, lower the frequency of tumour incidence and to discourage the multiplication of parasites.

Dr. J. S. Weiner (Oxford) dealt with the activity of sweat glands in man. He pointed out that an accurate census of sweat glands over the skin surface has still to be made, and that the degree of variation between individuals and races is unknown. We are largely ignorant even of the functional morphology of the individual gland. What, for example, is the blood supply of the duct of the gland, and what is the energy source of sweating ? Work at Oxford has begun with an investigation of technique. In Japan, Kuno has shown it to be possible to cannulate the ducts of single glands, and it has now proved possible to dissect out individual glands for study in the microrespirometer. Sweat itself can be collected in an arm bag or by washing down the body surface with water. By this second technique, which has now been adapted for serial sampling, the production of sweat can only be computed indirectly from the change of body-weight. Arm sweat has proved to be more concentrated than body sweat, though the proportions of solutes in the two are the same. About 95 per cent of the osmotic activity of sweat can be accounted for : approximately 80 per cent is due to chloride, 10–11 per cent to lactate, and 2–3 per cent to urea.

Preliminary studies have shown that although sweat glands are subject to fatigue, the rate of sweating increases with time of exposure to high temperatures ; its chloride concentration is related to the skin temperature. Acclimatization brings about increased sweating, and this is largely responsible for the increasing dilution of the sweat in the arm bag.

A clue to the source of energy for sweating is given by the fact that the lactate content rises in sweat from an arm rendered ischæmic by an arterial cuff. The chloride content drops in the earlier stages of ischæmia.

Prof. A. M. Boyd (Manchester) spoke of the treatment of excessive sweating by sympathectomy. The area of sweating can be mapped by painting the patient with a suitable indicator powder; but this is a messy method and its use makes it necessary to warm the patient up. It has been found possible to map the area of sweating by recording changes in the electrical resistance of the skin. The resistance of dry skin is only 10 per cent higher than that of damp skin; but the method now in use in Prof. Boyd's laboratory is sensitive enough to record it without warming the patient up.

Hyperhydrosis—excessive sweating—particularly of the extremities, can have serious consequences ; fungal infection and the allergic dermatitis and ulceration associated with it can be so severe as to simulate gangrene. Sympathectomy can abolish hyperhydrosis over the area of denervation, and is, of course, used for the treatment of other disabilities as well—in the relief of arterial block, for example, to ensure the establishment of a good collateral circulation. To abolish hyperhydrosis of the legs and feet, a sympathectomy involving the second and third lumbar ganglia is not always satisfactory, for the area of denervation may sometimes be confined to as small an area as the inner aspect of the calves. The best result is to be achieved by sympathectomy involving the first lumbar ganglion as well, and Prof. Boyd dismissed as an illusion the idea that this operation affects the fertility of the male.

Among the matters that arose in discussion at the end of the morning's session were the unsatisfactory state of our clinical knowledge of leucoderma (local skin depigmentation). Prof. Medawar said that leucoderma may be due to a local destruction of pigment-forming cells or to a temporary suppression of their pigmentary activity ; the latter is probably the explanation of the depigmentation caused by, for example, industrial anti-oxidants. In answer to a question on the distribution of mitoses in the epidermis, Dr. Bullough said that in his experience mitosis in normal skin is confined to the basal layer, that is, the epidermal cells at the dermo-epidermal interface. Mitosis may occur at a slightly more superficial level in hyperplastic skin.

[1] Findlay and Yang, *J. Agr. Sci.* (in the press).

OBITUARY

Mr. R. Winckworth

Ronald Winckworth, who died at his home at South Norwood on September 6, in his sixty-sixth year, was one of the best known British malacologists. He was educated at Epsom College (1896–1902) and at Jesus College, Oxford, where he read mathematics (1906–10). After leaving the University, he held a number of scholastic appointments and was teacher of mathematics at Brighton Technical College (1912–14). On the outbreak of war, Winckworth enlisted as a seaman, and later became paymaster-lieutenant. He served in several of H.M. ships and saw service in northern European waters and at Gibraltar.

After the First World War, Winckworth's love of natural history led him to accept a post as assistant at the Marine Biological Laboratory, Plymouth, and it was here that he laid the foundation for his later work on Mollusca. He left Plymouth in 1921 and, after some miscellaneous teaching and lecturing, spent six months studying natural history in India and Ceylon.

In October 1925, he joined the administrative staff of the Royal Society and worked at first on publications and later as librarian. He became assistant secretary in 1932 and assistant editor from 1937 until his retirement, due to ill health, in 1944.

From 1925 Winckworth devoted much of his leisure hours to the study of British and Indian Ocean Mollusca and published many papers, mainly in the *Journal of Conchology* and in the *Proceedings of the Malacological Society*. He never missed opportunities of collecting in the field ; but his official duties precluded much work on the living animal, and he became one of our foremost authorities on the systematics and bibliography of the Mollusca. His "British Marine Mollusca" (*J. Conch.*, **19** ; 1932) will be long remembered as a successful attempt to stabilize the names of our molluscs. In collaboration with his brother (the late Col. H. C. Winckworth) he began a long-term project to study Indian Ocean Mollusca, particularly the nudibranchs. This was not completed, due to his brother's death and his own ill health.