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THE AUSTRALIAN NATIONAL UNIVERSITY
JOHN CURTIN SCHOOL OF MEDICAL RESEARCH
ELECTRON MICROSCOPE UNIT

ANNUAL REPORT - 1965

STAFF

Professorial Fellow and Head of Unit:

E. H. Mercer, Ph.D. (Leeds), D.Sc. (Adel).

Electron Microscopist (Fellow):

M. C. Taylor, M.Sc. (Tas).

Fellow:

A. A. Barton, B.Sc., M.B., B.S. (Lond).

Research Fellow:

J. D. Pickett-Heaps, B.A., Ph.D. (Cantab).

Honorary Fellow:

Mary M. Hindmarsh, B.Sc., Ph.D. (Syd).

RESEARCH STUDENTS AND TEACHING ACTIVITIES

There are three research scholars proceeding to the Ph.D. degree: B. K. Filshie, M. R. Dickson and J. Pitha.

RESEARCH PROGRAM

The research of the Unit is concerned with the fine structure of cells and various cellular products including viruses. The comparative aspects of subcellular structure are being explored by the study of representative examples of a number of invertebrate phyla in collaboration with members of other Departments of the John Curtin School, the Department of Zoology, The School of General Studies and with members of the Division of Entomology, C.S.I.R.O.

VIRUSES AND NUCLEIC ACIDS

(a) Sericethis Iridescent Virus (S.I.V.)(Mercer, Day[†])

The analysis of the development of this virus in the cells of the fat body and epidermis of Galleria has continued. The virus is formed in the cytoplasm; large interconnecting chords of fibrous material traverse the cytoplasmic space and the virions appear at the periphery of these. Similar threads of Feulgen-positive material are visible in the light microscope indicating that these structures probably contain the viral DNA. Preliminary experiments, using autoradiographic methods are in progress, to trace the movement of DNA components.

The membrane, which encloses the DNA core of the virus, appears first as small crescents adjacent to the DNA pool, and grows to surround a sample of the pool much as happens in the formation of the pox viruses.

(b) Antheraea Virus (A.V.)(Mercer, Grace[†])

This small spherical virus, very similar in appearance to polio, which causes a fatal disease in the larva of the Emperor Gum Moth, forms in the nucleus of the mid gut cells of the insect. Large nucleoli-like bodies appear which prove to be almost crystalline arrays of the cores, a structural feature of this virus. A coat component appears to be added later to these cores to complete the virions, which then spread from the nucleus into the cytoplasm.

Purified preparations of the virus, disintegrated by means of ultrasonic vibration, show broken particles, cores and what are probably threads of DNA.

[†] a member of Division of Entomology, C.S.I.R.O.

(c) Other viruses

Vaccinia(Taylor, Fenner^P). A search for mutants showing structure changes has been made using material supplied by the Department of Microbiology.

SIV - DNA (Taylor, Bellett^P). A study of the length distribution of DNA molecules from this virus by means of the Kleinschmidt method is in progress.

Insect viruses. A number of other viruses of mammalian and insect origin have been examined in a preliminary way.

INVERTEBRATES

(a) Insects (Mercer, Filshie)

The morphological changes in the integuments of the blowfly and the green vegetable bug occurring during moulting and the deposition of the new cuticle have been followed. The complex, and regular surface pattern on the cuticle, surrounding the excretory pore of the scent glands of the vegetable bug, is generated by a particular arrangement of the cuticle cells.

One of the two glands, which are responsible for the production of the defensive secretion of the bug has been studied in detail.

(b) Rotifers (Mercer, Dickson)

The pedal gland and cilia of the gut, which have a peculiar internal spiral sleeve not previously described, have been studied.

Rotifer notably resist extreme dessication. Their membranous fine structure is tightly condensed when dried, and all internal cavities are effaced, but the structural organisation persists and is rapidly expanded when the animal is re-hydrated.

A comparative study of certain Gastrotricha and Acanthocephala related to Rotifer is in progress.

^P a member of the Department of Microbiology

(c) The tegument of Acanthacephala (Mercer, Nicholas [✓])

The early stages of the Acanthacephalan Moniliformis, which are passed in the common cockroach, have been examined and the development of the tegument followed. The parasite on passing through the mid gut wall is enclosed by the activity of the insect's haemocytes, whose products form a thick capsule for the growing parasite. The capsule is largely composed of condensed vesicles formed from the expansion of very fine tubular threads arising from the plasma membrane of the haemocytes.

(d) Fasciola hepatica (Mercer, Dixon[✓] and Clegg[✓])

The nervous system of the cercaria has been described. The neurones contain granules closely resembling the neurosecretory granules of higher organisms. Nerves are unmyelinated but in other respects are not exceptional. Neuromuscular junctions are also characterised by the same structural criteria as in vertebrates.

The encystment of the cercaria was described in the last Report (1964). Some further details have been obtained. The cytology of the cells synthesising the precursors of the walls of the cyst are typical of synthesising cells throughout the animal kingdom. The cellular movements by which these products are transported to the surface of the animal seem peculiar to the cercaria of this type of animal.

A detailed investigation of egg shell formation in liver fluke (Fasciola hepatica) is being carried out in parallel with histochemical studies. The fine structure of the egg-shell producing gland, the Mehlis Gland and other associated structures has been partly elucidated.

The tanned protein of the egg-shell itself shows an interesting two phase structure: fine spiral threads embedded in a less dense matrix. The surfaces of the shell are covered by a thin layer which appears to be lipid.

MARSUPIAL PHYSIOLOGY

Stomach of New Born Kangaroos (Barton, Griffiths[†])

From the moment that the young neonatus, which is only a gram in weight attached itself to the teat, secretion of acid and enzymes occurred. The stomach cells are complex in appearance and contain dense mitochondria, numerous large granules of variable electron density, probably a form of pepsinogen, a well defined Golgi region and a variable number of smooth surfaced vesicles. Microvilli are long and often branched. Intracytoplasmic canaliculi, conspicuous in mature animals, are absent in younger animals. The occurrence of pepsinogen as well as smooth vesicles, generally held to be associated with acid production, suggests that at these early stages one cell type is capable of mediating the functions later carried out by the parietal and pepsinogen cells.

FINE CYTOLOGY OF IMMUNOLOGICALLY COMPETENT CELLS
(Mercer, Morris[‡], Smith[‡], Cunningham[§])

A program of work concerning cellular aspects of immunology is in progress in the Departments of Experimental Pathology and Microbiology and electron micrographs are being made of cells of known characteristics from lymph and lymph nodes.

Small groups of individually selected cells (3-10), whose antibody producing capacity is first established by culturing them with monolayers of sensitive cells, have been examined. Early stages in antibody synthesis in cells are characterised by an abundance of free ribosomes in polysome clusters and a paucity of cytoplasmic reticulum. An interesting spiral cluster of some sixty ribosomes has been recognised.

[†] a member of the Division of Wildlife Research, C.S.I.R.O.

[‡] a member of the Department of Experimental Pathology.

[§] a member of the Department of Microbiology.

NERVE DEGENERATION AND LEPROSY (Barton)

An important lesion of leprosy involves the destruction of nerve fibres. The Schwann cell normally enveloping each nerve fibre comes to be filled with Mycobacterium leprae and death of the nerve fibre usually follows. An electron microscope study of the factors determining the phagocytotic activity of Schwann cells is being made. Experiments on cut nerves indicate that, at least in the sciatic nerve, phagocytosis by Schwann cells occurs. Perhaps degenerating myelin stimulates phagocytosis.

PLANT TISSUES (Hindmarsh)

Fungi. An investigation of the fine structure of some stages of the life cycle of Neurospora crassa is in progress. In the protoperithecium and early stages following fertilisation the perithecial wall increases in thickness accompanied by a break down in cell constituents.

Leaf surfaces. Leaf surfaces of broccoli and marrow-stem kale are being examined by carbon-replicas for differences between green and glaucous plants. Genes controlling the structure of leaf surfaces have been distinguished in these species.

OTHER INVESTIGATIONS

A study of the relation between epithelium and stroma in the intestine (rat and rabbit) has been initiated (Pitha). Enzymatically-active fractions of the cerebral cortex are being structurally analysed (Johnson)[✓]. The cuticle and other surface structures of Echinococcus is being studied in sections (M. Barton)[✗].

[✓] a member of the Department of Physiology.

[✗] a member of the Department of Zoology.

PUBLICATIONS

BARTON, A. A.**

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GRACE, T.D.C.[‡] and MERCER, E. H.

A new virus of the Saturniid Antheraea eucalypti Scott. J. Inverteb. Pathol., 7, 241-244, 1965.

DIXON, K. E.[♂] and MERCER, E. H.

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MERCER, E. H.

The contribution of the resistant cell membranes to the properties of keratinized tissues. J. Soc. cosmet. Chem., 16, 507-514, 1965.

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Intercellular adhesion and histogenesis. In "Organogenesis", Chapter 2, 29-53. (Eds. Ebert, Dehaan & Ursprung). Holt, Rinehart and Winston, New York, 1965.

MERCER, E. H.

"Cells and Cell Structure". IIInd Edition. Revised and Enlarged. Hutchinson, London, 1965. pp.117, ill. 70.

MERCER, E. H. and DAY, M. F.[‡]

The Structure of Sericesthis Iridescent Virus and of its Crystals. Biochim. Biophys. Acta., 102, (2), 590-599, 1965.

NICHOLAS, W. L.[♂] and MERCER, E. H.

The ultrastructure of the tegument of Moniliformis dubius (Acanthocephala). Quart. J. micr. Sci., 106, 137-146, 1965.

** Based on work done prior to joining this University.

‡ Not a member of this University.

♂ Based on work done while a member of the Department of Zoology.

♂ A member of the Department of Zoology.