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THE AUSTRALIAN NATIONAL UNIVERSITY
JOHN CURTIN SCHOOL OF MEDICAL RESEARCH
DEPARTMENT OF EXPERIMENTAL PATHOLOGY
ANNUAL REPORT - 1964

STAFF

Professor:

F.C. Courtice, M.A., D.Phil., D.Sc., L.R.C.P., M.R.C.S.,
M.C.P.A., Hon. F.R.A.C.S., F.R.A.C.P., F.A.A.

Professorial Fellows:

B. Morris, B.V.Sc., D.Phil.; S.V. Boyden, B.Sc.(Vet.Sci.),
Ph.D., M.R.C.V.S.

Fellow:

K.J. Lafferty, B.Sc., Ph.D. (from November).

Senior Research Fellow:

W.E. Stehbens, M.B., B.S., M.D., D.Phil., M.C.P.A., M.R.A.C.P.,

Research Fellows:

G. Woolley, M.Sc., Ph.D.; M.D. Silver, M.B., B.S., M.Sc.,
Ph.D., M.C.P.A.

National Heart Foundation of Australia Research Fellow:

W.J. Cliff, M.A., M.B., B.S., D.Phil.

Research Assistants:

R.J. North, B.Sc.; S.M. Faulkner, B.Sc.; M.A. Schneider,
B.Sc. (from March to August).

Head Technician:

J. Harding.

STUDENTS AND TEACHING ACTIVITIES

The following scholars were awarded the degree of
Doctor of Philosophy for theses with the titles indicated:
Mr. M.W. Simpson-Morgan - "Studies on interactions between the
metabolism of fat and carbohydrate"; Mr. J.G. Hall - "Function

of the lymphatic system in immunity"; Mr. V.P. Ackerman - "Delayed type hypersensitivity and acquired resistance in listeriosis"; Mr. R.B. Vaughan - "Discrimination by phagocytic cells";

Mrs. Maureen Sass was awarded the degree of Master of Science for a thesis entitled "Lymphatic system of the reproductive organs in pregnancy".

There are five students proceeding to the degree of Doctor of Philosophy: Mr. E. Adams, B.Sc., M.Sc. (commenced 5th April, 1962); Mr. R.J. North, B.Sc. (commenced 1st March, 1963); Mr. E. Gowland, M.B., B.S., L.R.C.P., M.R.C.S. (commenced 16th December, 1963); Mr. N. Tait, B.Sc. (commenced 6th January, 1964); Mr. J. Smith (commenced 1st April, 1964).

Members of the staff and several visitors have given Seminars within the Department during the year.

RESEARCH PROGRAMME

Effect of injury on capillary permeability to macromolecules (Courtice, Schneider)

Work has continued on the effect of injury on the permeability of the capillary wall to macromolecules, especially the lipoproteins.

(a) Effect of graded injury

Electron microscopy has shown that the leakage of macromolecules or of particles across the capillary wall of an inflamed tissue or after the application of serotonin or of histamine occurs through gaps between the endothelial cells. On the other hand, this method has not shown any leakage between the cells in normal tissues. Since, however, the exact mechanism of transfer of materials across the normal endothelium has not yet been clarified, it is not known whether the effect of injury is an exaggeration of a normal mechanism or is a quite different process.

Experiments have been performed to study the transfer of albumin and three classes of lipoproteins from plasma to lymph in the paw of the hypercholesterolaemic rabbit before and after injury of the paw at one of the following temperatures for 1 minute:- 50, 52.5, 55, 57.5, 60 and 70°C. The results showed that in each case there was a molecular sieving effect related to the size of the molecules, that the degree of molecular sieving decreased with severity of the injury and that, assessed by the lymph:plasma ratios of the concentrations or by the total transfer of each substance, there was a graded response from normal depending on the severity of the injury.

(b) Effect of local temperature on capillary permeability after injury

The effect of altering the local haemodynamics on the transfer of albumin, globulin and the lipoproteins across the capillaries in the skin of the paw of the hypercholesterolaemic rabbit has been studied after injuring both hind paws at 60°C for 1 min. One paw was then kept at 10°C and the other at 45°C, so varying the filtering pressure and the blood flow. In each case there was molecular sieving of the various macromolecules. The amount of transfer of each macromolecule and lymph:plasma ratio in each case was much greater in the paw kept at 45°C while the degree of molecular sieving was less. These experiments suggest that the gaps between the endothelial cells and the pores of the molecular sieve are increased in size with increased capillary pressure.

The exact mechanism of transfer of materials across the endothelial barrier has not yet been elucidated. The experiments described are in keeping with a view that the effect of injury may be an exaggeration of the transfer in the normal tissue. If the basement membrane acts as a sieving mechanism, it seems that the pores of this sieve are altered by increased intensity of injury or by a change in the filtering pressure.

The pathogenesis of atherosclerosis (Stehbens)

The investigation of the nature of intimal proliferation in arteries with special reference to lipid deposition has been continued. The precise location of early spontaneous lipid deposition in the cerebral arteries of sheep was determined by serially sectioning a large number of vascular bifurcations. Lipid deposition was always found to be localized to the zone of intimal thickenings, the distribution of which was similar to that already determined in man and other animals. The findings support the belief that this thickening is an important precursor of atherosclerosis.

The vascular changes about 42 chronic gastric ulcers were studied histologically and were compared with those in vessels at some distance from the ulcers. The findings were at variance with the opinions given by current textbooks of pathology. The vascular changes observed about the ulcers were essentially degenerative with striking similarities to atherosclerosis, diffuse hyperplastic sclerosis (arteriosclerosis) and arteriolo-sclerosis, even to the extent of lipid deposition. The local accentuation of lipid deposition in vessels in chronic peptic ulcers may provide an important clue to the aetiology of atherosclerosis.

Endothelium and platelets (Stehbens, Silver)

The fine structure of endothelium is currently being investigated in the frog and rabbit in an attempt to throw light on the physiology of capillary permeability. A study of mitosis in regenerating endothelium following experimental injuries to veins has also been completed.

The "sticking" of platelets to endothelium has also been investigated using the transparent ear chamber technique in rabbits. The behaviour of platelets in non-inflamed, inflamed and damaged ear chambers and following the intravenous injection of a variety of compounds which induce platelet aggregation. Dr.

Silver is now endeavouring to elucidate the mechanism of platelet agglutination following the injection of adenosine diphosphate (A.D.P.).

Structure of the walls of large arteries (Cliff)

The cellular mechanisms involved in the formation, maintenance and degeneration of elastic fibres are poorly understood. The thoracic aorta of the rat and the mouse and the thoracic aorta and its proximal branches of the budgerigar were studied with the electron microscope. Particular attention was given to the appearance of the elastic fibres and also to the relationship of the various cell types of the vessel wall to these fibres during the processes of growth and ageing. In addition groups of rats and mice had silver nitrate added to their drinking water in an attempt to produce in vivo staining of the elastic fibres during the growth of the animals. These experiments are being continued.

The fine structure of the lymphatic and blood capillaries of the ovary (Morris)

The finding that large volumes of lymph form in the ovary during the luteal phase of the oestrus cycle and during pregnancy indicated that significant alterations occur in the exchange of fluid and protein across the capillary wall following the development of the corpus luteum. The electronmicroscopic appearance of the blood capillaries of the corpus luteum and the ovarian follicles and stroma have been examined to see if any morphological changes exist in these vessels which could explain their greatly increased permeability.

When marker particles such as India ink and ferritin are injected intravenously into pregnant and cycling rats and into pregnant sheep these particles escape rapidly from the ovarian blood capillaries through large gaps in their walls. The most extensive leakage occurs in the luteal capillaries but the capillaries in the stroma also have gaps which allow the

passage of particles across their walls. The gaps in the capillaries are distinct from the intercellular junctions although in many cases the intercellular junctions are patent and show no desmosomes. A basement membrane surrounds most of the capillaries but it is often incomplete.

The leaky nature of the capillaries persists in the rat ovary at least up to the 16th day of pregnancy and in the sheep up to the 60th day of pregnancy. This suggests that the increased permeability of these vessels is not due to their recent formation, but that it is due more likely to the physiological activities of the tissue cells which surround them.

Lymphatics of the uterus in pregnancy (Sass)

The lymphatic vessels of the uterus in the Merino ewe were injected and studied, in the non-pregnant and at various stages in pregnancy. The flow of lymph from the reproductive organs was estimated by comparing lymphatic flow rates in the lumbar collecting trunks in non-pregnant and pregnant sheep. The lymph was collected over several weeks in the conscious animal, and was analyzed for protein and hormone content. The lymphatic vessels in the wall of the uterus increase in size and probably also in number, although to a lesser extent. Lymphatics in the muscularis layer are interlaced with the muscle and connective tissue fibres, and are usually perivascular in position.

Flow of lymph from the uterus increases dramatically during pregnancy from a non-pregnant level of 15 ml/hr to a flow of 200 ml/hr or better at term or in the immediate post partum. Lymph flow during labour fluctuates with each contraction, ceases almost completely during the expulsion of the foetus and then rises abruptly and remains high for 2 or 3 days after delivery. The level then falls to approximately 100 ml/hr and remains at this level for a variable period, depending on the activity of the mammary gland. A mammary cannulation at this

time showed that about 75% of the lumbar lymph was of mammary origin.

The transport and metabolism of long chain fatty acids in sheep
(Morris, Adams)

The distribution of long chain fatty acids has been studied in the plasma of sheep and in lymph derived from the liver, hind limbs, mammary gland and the gut. The fatty acid composition of the intestinal lymph lipids was very different from that of the plasma and lymph from other areas of the body. The characteristic feature of the intestinal lymph fatty acids was the presence of a high proportion of stearic acid and of trans-9-octadecenoic acid. There were also iso- and anteiso- branched chain fatty acids present. These saturated acids, geometrical isomers and branched chain fatty acids were not present to any extent in the diet and it was considered that they were formed in the rumen by the action of the ruminal microorganisms.

The effect of pregnancy on the lipids of the plasma and mammary gland lymph and their fatty acid composition (Morris, Adams)

The level of lipid in the plasma of pregnant ewes near term was about twice that of non-pregnant ewes. This lipaemia occurred as a progressive increase starting about the 8th week of pregnancy. The levels of cholesterol esters and phospholipids in the plasma increased in the early stages but during the last four weeks the level of triglycerides rose rapidly and remained high throughout the period of lactation. Mammary gland lymph collected during late pregnancy and early lactation and had a low content of lipid, the concentration being only 18% of the plasma levels. This was thought to reflect a high rate of utilization of lipid by the mammary gland.

A significant change occurred in the fatty acid composition of the cholesterol esters of the plasma and mammary gland lymph during pregnancy. This change involved oleic and linoleic acids and occurred within the first weeks. Oleic acid accounted for 53% and linoleic acid 34% of the C-18 fatty acids

in the plasma of non-pregnant sheep; the relative amounts of these acids changed during pregnancy so that oleic acid was 35% and linoleic acid 52% of the C-18 fatty acids of the cholesterol esters. These changes were reflected in the cholesterol esters of the lymph from the mammary gland. During the first week following lambing the fatty acid composition of the cholesterol esters reverted to that found before pregnancy. It appeared likely that these changes in the level of polyunsaturated fatty acids in the plasma might be related to the requirements of the developing foetus for essential fatty acids.

The composition of the lipids isolated from the rumen of sheep fed on lucerne (Adams, Morris)

In an attempt to establish at what level in the digestive tract modifications occur in the dietary lipids, the contents of the rumen were analysed for their lipid composition and compared with the lipid composition of lucerne.

The lipids of lucerne were mostly galactolipids (38%) and phospholipids (29%); the fatty acid composition of these lipids was made up of linolenic acid (67%) and linoleic acid (15%). In the rumen most of the fatty acid present was in the form of free fatty acids with only traces of ester bound fatty acids. The phospholipids isolated from the rumen bacteria and protozoa were very different from those of lucerne. The principal phospholipids of lucerne were phosphatidyl choline and phosphatidyl ethanolamine, but neither of these phospholipids was isolated from the ruminal microorganisms. The polar lipids from the microorganisms were not identified precisely but from hydrolysis, paper chromatography and infra-red spectroscopy they appeared to be substituted amides.

The fatty acids of the rumen lipids had a much lower proportion of linoleic and linolenic acids than did lucerne. The rumen fatty acids were a mixture of geometrical isomers, cis-9-octadecenoic, trans-9-octadecenoic and trans-10 or 11-octadecenoic acid. Of these acids the trans-9-octadecenoic acid

was the major component. It was considered that the C-18 trans isomers were formed during the hydrogenation of linoleic and linolenic acids.

The polar lipids isolated from the rumen bacteria contained a high proportion of branched chain acids of the iso and anteiso series. The iso series of acids were of chain lengths 12:0, 13:0, 14:0, 15:0, 16:0, 17:0 and 18:0 whereas the anteiso series involved only odd number carbon chains 13:0, 15:0 and 17:0. It was thought that these branched chain fatty acids were synthesized by the rumen bacteria. These bacteria were subsequently digested lower down in the gut and their constituent fatty acids absorbed by the sheep.

The composition of the intestinal lymph lipids from sheep fed cod liver oil or tung oil (Morris, Adams)

No experiments have been reported in which the absorption of naturally occurring long chain fatty acids with different structural features has been studied in sheep. The extent and specificity of rumen hydrogenation towards various fatty acid substrates has been examined by feeding cod liver oil, tung oil and olive oil to sheep and analysing the intestinal lymph. The various oils were given both into the rumen or into the abomasum.

When tung oil was fed into the abomasum none or only trace amounts of elaeostearic acid (9.11.13 octadecatrienoic acid) were absorbed. When tung oil was fed into the rumen however, elaeostearic acid was absorbed into the lymph in significant amounts. There was no evidence that the linolenic acid isomers of tung oil were not hydrogenated to stearic acid as occurs when linolenic or linoleic acids are fed.

When cod liver oil was fed into the abomasum the characteristic long chain polyunsaturated fatty acids of the oil appeared in the lymph in very small amounts. When the oil was fed into the rumen however the C-20 and C-22 polyunsaturated fatty acids were readily absorbed into the lymph. The saturated C-20 (behenic) and C-22 (arachidic) acids however did not show

any increase nor was there any increase in other C-20 and C-22 acids of a lower degree of unsaturation than those fed in the cod liver oil. This suggested that the polyunsaturated acids, although of cis configuration were not acceptable substrates for hydrogenation in the rumen.

As neither tung oil nor cod liver oil was absorbed to any extent when fed directly into the abomasum, it appeared likely that some changes to these oils took place in the rumen which prepared them for subsequent absorption. In order to test whether hydrolysis in the rumen facilitated absorption of the long chain fatty acids of tung oil and cod liver oil an experiment was done in which the constituent fatty acids of cod liver oil were prepared by alkaline hydrolysis and then fed into the abomasum. When the free acids were fed in this way they were readily absorbed into the lymph.

Studies on the cell population of single lymph nodes (Hall, Morris)

The changes in the output of cells in the lymph coming from the popliteal lymph node have been studied in unanaesthetized sheep by cannulating the efferent duct of the popliteal node and collecting the lymph quantitatively for long periods of time. Previous experiments carried out on such preparations suggested strongly that many of the lymphocytes in the lymph are not produced in the node but are derived from the blood supply to the node; the lymphocytes leave the blood stream within the substance of the node and migrate into the lymph stream.

In order to test this hypothesis a series of experiments was performed in which the popliteal lymph node was perfused continuously, via an afferent lymphatic, with a saline solution containing ^3H -thymidine. In this way a high concentration of ^3H -thymidine was maintained in a single popliteal node for periods of several days. Any cell formed in the lymph node during the period of the perfusion thus incorporated the radioactive label into its nuclear DNA and could be identified sub-

sequently by autoradiographic techniques. An analysis of the labelling pattern seen in autoradiographs prepared from the cells in the efferent lymph from the perfused nodes showed that no more than 4% of the lymphocytes in the lymph had been produced in the node. The remaining 96% had come, presumably, from the blood supply to the node.

In this way the lymphocyte population of the body is continually brought into contact with the phagocytic cells in the lymph nodes. These fixed, phagocytic cells may contain antigenic material and it is envisaged that any lymphocyte capable of reacting with the particular antigen is selected out and retained in the node to initiate the cellular events of the immune response.

Properties of macrophages studied in vivo (Cliff)

There is no good agreement regarding the properties possessed by this type of cell in the living animal which plays an important part in the removal of dead and foreign material, in the inflammatory reaction, in wound healing and in immunological processes as well as in various disease processes including atheroma. Accordingly the ability of these cells to move within the tissues was studied in rabbit ear chambers. To do this, discrete populations of these cells were labelled by the local injection of colloidal carbon into modified Sandison-Clark rabbit ear-chambers and the behaviour of the labelled cells was followed during the healing reaction and during an extended period following complete healing when they were present in mature scar tissue. Results so far obtained suggest that these cells move only extremely slowly and tend to do so along the outside of the blood vessel walls in the scar tissue. These observations are being continued.

Tissue reaction to antibody-antigen complex studied in vivo (Cliff)

Minute quantities of antibody-antigen complex were injected into a modified form of Sandison-Clark rabbit ear-chambers. The presence of this complex in a circumscribed

region in the ear-chamber evoked an acute inflammatory reaction as evidenced by alterations in the nature of the blood flow in the vessels draining the area and by the sticking and emigration of leucocytes from the related venules. Accumulation of large numbers of leucocytes in the tissue in the region of injection of the complex was identified. These experiments will be continued with the purpose of elucidating the role of any chemotactic influence that may be exerted on the leucocytes by the injected antibody-antigen complex.

Myocardial autografts in rabbit ear-chambers (Cliff)

Various methods for obtaining myocardial biopsies in rabbits were employed with the view to grafting myocardial tissue into rabbit ear-chambers where it would be available for prolonged microscopic study in its living state. The most satisfactory results to date have been obtained using a percutaneous needle biopsy technique. Once a satisfactory operative mortality has been achieved biopsies will be made on rabbits with graft chambers in their ears so that tissue autografting may be performed immediately the biopsy is obtained.

Cell biology (North, Boyden, Faulkner)

Investigations have continued on the responses of phagocytic cells to foreign matter. The work has involved experiments on the actual process of phagocytosis and on the mechanisms by which the phagocytic cells discriminate between components in their environment.

The results of many experiments indicate that phagocytosis is an energy-requiring process which utilises adenosine triphosphate (ATP). Similarly, the ability of phagocytic cells to spread on glass has been shown to be influenced by ATP.

Histochemical and electron microscopic studies showed that the plasma membrane of phagocytic cells contains an enzyme which specifically hydrolyzes ATP. This enzyme is inhibited by

a series of components which also inhibit phagocytosis and the capacity of the cells to spread out on glass. It is believed that the plasma membrane may act as a mechano-enzyme.

The number of particles which may be ingested by phagocytic cells is a function of the particle diameter, so that there is a constant relationship between the number of particles ingested and the particle diameter.

It is known that the ability of phagocytes to recognize and respond to foreign particles is usually dependent on the interaction of specific antibody-like components of serum with a particle surface. There has been considerable controversy on the question whether non-specific serum factors, like complement, also play a role in this process. Experiments have shown that in certain instances maximum phagocytosis may occur in the absence of any such non-specific serum substances, while in other instances non-specific components of normal serum greatly facilitate the phagocytic response.

Serology (Gowland, Faulkner, Boyden)

Work has continued on cytophilic antibody. It was found that cytophilic antibody to sheep red cells is produced in guinea pigs only when the antigen is injected with Freund's complete adjuvant. Little or no cytophilic antibody appears in the serum when incomplete adjuvant is used or when the antigen is injected alone. Skin testing produces a marked rise in the serum levels of this antibody.

Investigations have been carried out to elucidate the physico-chemical properties of cytophilic antibody. Separation on DAC DEAE cellulose of guinea pig gamma-globulins into fractions of different electrophoretic mobilities does not separate cytophilic antibodies from the classical non-cytophilic antibodies.

A method has been worked out for determining the combining capacity of antisera to soluble antigens, using

Sephadex G200 columns and an antigen labelled with a radio-active isotope. The method measures directly the amount of antigen combined with antibody, and it is not dependent upon any secondary manifestation of this reaction.

Comparative immunology (Tait, Clegg, Boyden)

Studies have commenced on comparative immunology. The aim of the work is to provide information on some of the immune mechanisms active in smaller vertebrates and invertebrates, partly because of their intrinsic interest and also because it is felt that more knowledge on this subject would help towards the understanding of the more complex situation in higher animals.

Studies are being carried out on the presence and nature of natural antibodies in frogs and on antibody production in this species against a variety of antigens. Cellular immunity in frogs is also being studied including the nature of the cellular response in inflammation, the phagocytic properties of normal and immune cells and the presence of cytophilic antibody.

Virtually nothing is known of hypersensitive responses in the lower vertebrates and this subject is also under investigation. Studies are also being carried out on a possible immunological relationship between the frog host and its opalinid parasite. It is believed that host-specificity of the parasite may be determined by an immunological mechanism.

Experiments have shown that snail blood contains substances with biological activities similar to those of the antibodies of vertebrate blood. Work is in progress on the physicochemical nature and biological significance of these substances.

Liver haemodynamics and lymph production (Woolley)

Work on this topic has been continued since the previous report. The investigation has been concerned with the interrelations of the following parameters in the unanaesthetized sheep: central arterial blood pressure, portal venous pressure,

hepatic venous pressure, portal blood flow, hepatic lymph flow and composition. Preliminary analysis of the large amount of data accumulated reveals a number of matters of interest. All vascular pressures measured, both mean and pulsatile are considerably more labile than could be expected from work on anaesthetised animals. Variation in mean values on a one hourly basis are, very approximately:- arterial pressure $\pm 5\%$, portal pressure $\pm 10\%$, hepatic venous pressure $\pm 25\%$, portal blood flow $\pm 16\%$. Similarly for derived parameters:- estimated sinusoidal pressure $\pm 50\%$, splanchnic resistance $\pm 20\%$, sinusoidal resistance $\pm 23\%$. No clear correlation has been found between variations in sinusoidal pressures and hepatic lymph formation. This suggests that the filtering area and hydraulic resistance of the liver of lymph formation are also more labile than previously assumed. It has been possible to estimate hydraulic resistance to lymph formation for the first time in any vascular bed. This is high, circa 3×10^6 Absolute units, compared with splanchnic resistance (to blood flow) 10×10^3 Absolute units, sinusoidal resistance 2×10^3 Absolute units. The question is raised whether the resistance to liver lymph formation can be attributed largely to the sinusoidal walls themselves or to extravascular resistance between sinusoids and lymphatics.

Experiments have also been performed to examine the effects of vasoactive drugs on liver haemodynamics. Adrenaline had the expected vasoconstrictor effect on both the splanchnic and sinusoidal bed. However there appears to be a fairly prolonged vasodilation of the splanchnic bed after the initial vasoconstriction. Estimated sinusoidal pressure remains elevated after adrenaline.

Pulsatile propulsion of lymph (Woolley)

It was reported previously by Hall, Morris and Woolley that in the unanaesthetized sheep, lymph propulsion is predominantly affected by rhythmic propulsive contraction of the

lymphatics themselves. Following the demonstration of the essential phenomenon, work is in progress to study the mechanism of lymphatic contraction in more detail. Although it has long been known that those lymphatics which have smooth muscle in their walls are innervated, the role of the innervation is unknown.

Experiments are being conducted to test the responses of lymphatic vessels of the unanaesthetized sheep to both local and systemically administered drugs.

OTHER ACTIVITIES

Professor Courtice was on study leave for three months visiting laboratories in the United States, Canada and England and attending the thirteenth General Conference of Unesco in Paris as a member of the Australian Delegation.

Dr. Boyden read papers at a Symposium on "Complement", Ciba Foundation, London, in May and at a Symposium on "Molecular and Cellular Basis of Antibody Formation", Czechoslovakian Academy of Sciences, Prague, in June.

Dr. Morris was on study leave from September 2nd. He is working in the department of Physiology at Oxford with Lord Florey and will spend the second half of his study leave in Paris working with Dr. M. Bessis.

Several members of the department read papers at the meetings of the Australian Physiological Society held at Monash University, of the College of Pathologists held at the University of New South Wales and of ANZAAS held in Canberra.

Dr. J.G. Hall was awarded a Beit Memorial Fellowship for Medical Research to work at Dabraham. Dr. G. Woolley was appointed Lecturer in Physiology at Monash University. Dr. R.B. Vaughan was awarded an N.I.H. Fellowship to work at Yale. Mr. E. Adams was awarded an M.R.C. Fellowship to work at the Lister Institute. Dr. A.K. Lascelles, a former Research Fellow

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of the department, has been appointed to the first Chair of Dairying in the University of Sydney. Dr. T.J. Heath has been appointed Senior Lecturer in the Veterinary School of the University of Melbourne.

The work of the department has been partly supported by grants from the National Heart Foundation of Australia and from the World Health Organization.

PUBLICATIONS

BOYDEN, S.V.

'Cytophilic antibody in guinea-pigs with delayed-type hypersensitivity.' Immunol., 7, 474.

'Use of radio-active labelled proteins for the detection of cell-fixed antibodies in immunological methods.' In Immunological Methods (ed. J.F. Ackroyd and J.L. Turk), Blackwell's, Oxford.

'Autoimmunity and inflammation.' Nature, 201, 200.

COURTICE, F.C., MUNOZ-MARCUS, M.

'The composition of the plasma lipoproteins in experimental hyperlipaemia induced by Triton WR1339, cortisone, alloxan and haemorrhage in rabbits.' Quart. J. exp. Physiol., 49, 430.

COURTICE, F.C., MUNOZ-MARCUS, M., GARLICK, D.G.

'The permeability of the blood capillaries of the leg on the lipoproteins in various hyperlipaemic states in the rabbit.' Quart. J. exp. Physiol., 49, 441.

GOWLAND, E.**

'Studies on the emigration of polymorphonuclear leucocytes from skin lesions in man.' J. Path. & Bact., 87, 347.

HALL, J.G., MORRIS, B.

'The effect of x-irradiation of the popliteal lymph node on its output of lymphocytes and immunological responsiveness.' Lancet, ii, 1077-1080.

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

HEATH, T.J., ADAMS, E.P., MORRIS, B.

'The fatty acid composition of intestinal lymph lipids in sheep and lambs.' *Biochem. J.*, 22, 511.

MICHAEL, C.A.[†], CLIFF, W.J.**

'Response of myometrial autografts in the rabbit ear-chamber to oxytocin during pregnancy.' *Aust. N.Z. J. Obstet. Gynaec.*, 4, 107.

MISHKEL, M.A., MORRIS, B.

'The metabolism of free fatty acids and chylomicron triglycerides by the perfused choline deficient rat's liver.' *Quart. J. exp. Physiol.*, 49, 21.

'The synthesis of lipid from acetate-2-¹⁴C in the isolated perfused normal and choline deficient liver of the rat.' *Aust. J. exp. Biol.*, 42, 189.

NELSON, D.S., DAY, M.F.[†]

'The detection of cauliflower mosaic virus by means of immune adherence.' *Phytopathology*, 54, 395.

SILVER, M.M.[†], McMILLAN, G.C.[†], SILVER, M.D.**

'Haemolytic anaemia in cholesterol-fed rabbits.' *Brit. J. Haemat.*, 10, 271.

STEHBENS, W.E.

'Localization of spontaneous lipid deposition in the cerebral arteries of sheep.' *Nature, London*, 203, 1294.

'Vascular changes in chronic peptic ulcer.' *Arch. Path.*, 78, 584.

Editorial, *Am. Med. Assoc.*

[†] Not a member of this University

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

VAUGHAN, R.D., BOYDEN, S.V.

'Interactions of macrophages and erythrocytes.' Immunol.,
7, 118.

ACCEPTED FOR PUBLICATION

BOYDEN, S.V.

'The occurrence and significance of natural antibodies.'
In Molecular and Cellular Basis of Antibody Formation,
Symposium of Czechoslovakian Academy of Sciences, Prague.

'Natural antibodies.' Advances in Immunology, 5.

BOYDEN, S.V., NORTH, R.J., FAULKNER, S.M.

'Complement and the activity of leucocytes.' In Ciba
Symposium on "Complement".

CLIFF, W.J.**

'Kinetics of wound healing in rabbit chambers, a time
lapse cinemicroscopic study.' Quart. J. exp. Physiol.

COURTICE, F.C.

'The possible significance of some animal experiments in our
understanding of the origin of atherosclerosis in man.'
Italian J. of Atherosclerosis.

GARLICK, D.G., COURTICE, F.C., MUNOZ-MARCUS, M.

'Plasma lipoproteins in hyperlipaemic states in man and in
the rabbit.' Australasian Annals of Med.

HALL, J.G., MORRIS, B., WOOLLEY, G.

'Intrinsic rhythmic propulsion of lymph in the
unanaesthetised sheep.' J. Physiol.

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

LINDNER, H.R.**, SASS, M.B., MORRIS, B.

'Steroids in the ovarian lymph and blood of conscious ewes.' J. Endocrin., 30, 361.

MORRIS, B., SIMPSON-MORGAN, M.W.

'Effects of glucose on the metabolism of infused chylomicron fatty acids in unanaesthetized rats.'
J. Physiol.

NELSON, D.S., NORTH, R.J.

'The fate of peritoneal macrophages after the injection of antigen into guinea pigs with delayed-type hypersensitivity.' Lab. Invest.

SILVER, M.D., STEIBENS, W.E.

'Platelet behaviour in vivo.' Quart. J. exp. Physiol.

SILVER, M.D., STEIBENS, W.E., SILVER, M.M.**

'Platelet reaction to adenosine diphosphate in vivo.'
Nature, London.

STEIBENS, W.E.

'Endothelial cell mitosis and permeability.' Quart. J. exp. Physiol.

'The early lesions and inter-relationship of atherosclerosis and thrombosis.' Journal of the Indian Medical Profession,

'Atypical cerebral aneurysms.' Med. J. Aust.

STEIBENS, W.E., MEYER, E.

'Ultrastructure of endothelium of the frog heart.'
J. Anat., London.

VAUGHAN, R.B.

'Interactions of macrophages and erythrocytes: some further experiments.' Immunol.

'The discriminative behaviour of rabbit phagocytes.' Brit. J. exp. Path.

'The comparative in vitro phagocytic activity of rabbit polymorphonuclear leucocytes and macrophages.' Brit. J. exp. Path.

'The romantic Rationalist, a study of Elie Metchnikoff.' Med. History.