from fowl paralysis. Holmes (1961), on the other hand, found a few cases of leucosis in his transmission experiments with osteopetrosis, but he points out that the recipient fowls came from flocks showing a moderate incidence of leucosis, and he therefore does not regard these cases as significant. Carr and I have studied three virus-associated fibrosarcomas from field cases, but we have not had Burmester's experience of the occurrence of lymphoid leucosis or erythroleucosis in any of our experiments, either with these (Carr & Campbell 1958) or with Rous sarcoma. Renal tumours produced by erythroleucosis virus and osteopetrosis virus and sarcomas developing at the site of inoculation with erythroleucosis material certainly demonstrate a wider cytotropism than some of us used to think possible with pure virus strains. However, it must not be overlooked that both the renal tumours and the sarcomas do not appear to be able to exist in their own right, and that Pikovski & Doljanski (1950) state that cell-free erythroleucosis virus is incapable of producing a sarcoma at the site of injection. The renal adenomas bear no resemblance to the common kidney tumours of fowls, which are embryonal in character (Wilms' tumour), but as they are apparently stimulated to growth from small subcapsular groups of immature tubules whose capacity for differentiation at the time of exposure (i.e. under 2 weeks of age) to these viruses is extremely limited, it could be postulated that the same viruses acting on the renal anlage at an early stage of embryonic development in the egg might give rise to the complex growths which are embryonal nephromas or Wilms' tumours. But this does not prove that these viruses are related in any way, for it may well be that a number of different stimuli could have similar effects.

One of the major criticisms of much of the published work on the leucoses and allied conditions is that research has been mainly confined to a few long-established laboratory strains, which may well have been modified by years of passage and so may bear only a slight resemblance to the original field cases from which they were derived. For example, the Rous sarcoma, now in its 52nd year of propagation, exists as at least three distinct laboratory strains, each with distinctive antigenic properties (Simons & Dougherty 1961). Despite all this effort, we still do not know how the virus of similar sarcomas, or of the leucoses, is spread in nature, and why field cases never assume epidemic proportions. Although the leucosis agents are egg-transmitted, Rous sarcoma is not (Carr 1944).

The extensive literature on the possible relationship of all these conditions has been reviewed by Furth (1935), Oberling & Guérin (1954), Panina (1957), Andervont (1959), Chubb & Gordon (1959) and Beard (1961).

My own opinion is that the evidence for bringing such diverse conditions as fowl paralysis, osteopetrosis, fibrosarcomas, kidney tumours and hæmangiomas into the leucosis complex is not conclusive, since the possibility of mixed viruses has not been eliminated, nor has due allowance been made for the natural occurrence of some of these diseases in the experimental stock when transmission experiments are being interpreted. These views have already been stated more fully elsewhere (Campbell 1961).

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An Analysis of the Action of Rous Sarcoma Virus *in Vivo*

We have studied the conditions necessary for the successful infection with Rous sarcoma virus (R.S.V.) of turkeys which normally are resistant. We would point out, also, that R.S.V. after fifty years' maintenance in many laboratories is no longer a single entity and that to-day several antigenically distinct strains exist.

Starting with the assumption that rejection of

Rous sarcoma by the turkey was the result of an immunological reaction against the virus itself, it was reasoned that since the virus had chick antigens associated with it (as well as specific antigens) it might be possible to infect young adult turkeys if they were first made tolerant to chick antigens (Harris 1956, 1958).

It was found that injection of chicken blood intravenously into turkey embryos or into newly-hatched turkeys rendered them tolerant. Such turkeys, when challenged with cell-free R.S.V. seven to ten weeks later, developed tumours. It was also found that living chicken cell inocula were not required; soluble extracts of chicken blood cells would suffice and heterologous cells could produce the same effect.

Exhaustive analysis of chick blood cell extracts indicated that the tolerance-conferring antigen was free from RNA, DNA or protein; contained fucose; and inhibited the agglutination of group A blood cells by specific antiserum, i.e. it is a blood group substance (Harris & Simons 1958, 1962). Experiments with blood cells from chickens, guinea-pigs and man; phenol extracts of chicken blood; and purified hog and human blood group substances confirmed that the tolerance-conferring antigen is a blood group substance.

This finding has been confirmed by Svoboda and his colleagues in Prague, but Prince and others in the U.S.A. were unable to get similar results. The reason for this became apparent when Dougherty brought from the U.S.A. Bryan's strain of R.S.V. (R.S.V. (B)) and when a strain of the virus (R.S.V. (29)) which Purdy had stored in the cold-room at Mill Hill in 1929 was found. R.S.V.(B) was shown to be antigenically distinct from R.S.V.(H) and R.S.V.(29) is also different. Prince's virus was R.S.V.(B) and Svoboda's virus is serologically related to R.S.V.(H).

From 1958 onwards workers in Russia, Czechoslovakia, Germany (Schmidt-Ruppin 1959) and Sweden had reported the production of hæmorrhagic cysts and sarcomas after injection of large inocula of Rous sarcoma cells from chickens into newborn, or young, rats and hamsters. As rats and hamsters are genetically much further apart from chickens than are turkeys these findings at first caused surprise.

The strain of virus used in Sweden, R.S.V.(AL) was obtained from Professor Ahlström (cf. Ahlström & Forsby 1962, Ahlström & Jonsson 1962) and it is believed to be identical with the strain used by Zilber & Kryukova (1957), Zilber (1960) and Svet-Moldavsky (1957, 1958) in Russia and by Svoboda (1960*a*, *b*, 1961, 1962) in Czechoslovakia. With this strain, but not with R.S.V. (H), it was possible to produce multiple cysts and tumours in hybrid rats inoculated when newborn. The rat tumours so produced were readily transplantable into newborn rats, less so into hamsters, and first grew but then regressed in chicks.

These transplantable rat tumours are composed of rat, not of chicken, cells. Squash preparations of cells of a colchicine-treated rat tumour graft showed none of the micro-chromosomes which are numerous in chicken tumour cells.

Further work is necessary to determine the relationship of R.S.V.(AL) to the other strains. It is of low potency for day-old chicks and produces pocks in the chorioallantoic membrane similar to those produced by R.S.V.(B). It is serologically related to R.S.V.(H) but, while R.S.V.(AL) is infectious for rats, R.S.V.(H) is not.

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Professor B Thorell (*Karolinska Institutet, Stockholm, Sweden*) read a paper on **Cytogenesis of Fowl Leucosis and Allied Tumours.** He reviewed research work published in the following papers:

Ambs E & Thorell B (1958) *Acta hæmat.* **21**, 284
Bayreuther K & Thorell B (1959) *Exp. Cell Res.* **18**, 370
Brody S, Johannisson E & Thorell B (1959) *Cancer Res.* **19**, 1025
Pontén J & Thorell B (1957) *J. nat. Cancer Inst.* **18**, 443
Thorell B (1960) *VII Int. Congr. Hæmat.* (Rome 1958) Vol 3 p 582
Thorell B (1960) In: Reticuloendothelial Structure and Function. Ed. J H Heller. New York; p 273

Dr John Hindley (*M.R.C. Laboratory of Molecular Biology, Cambridge*) read a paper on **The Effect of Actinomycin D on Nucleic Acid Synthesis and Virus Production in R.S.V.-infected Cells.**

He said that under conditions in which more than 99% of the normal host cell DNA-dependent RNA synthesis was inhibited, the rate of synthesis of Rous sarcoma virus (R.S.V.) in infected cells was virtually unaffected. In this, R.S.V. synthesis was qualitatively similar to the synthesis of the cytocidal RNA viruses, e.g. Mengo and polio virus. It was concluded that R.S.V. RNA synthesis was mediated by an RNA-dependent RNA polymerase and that the malignant transformation required only virus synthesis and the subsequent change in the nature of the cell membrane due to the accumulation of viral antigen.

The full paper will be published in *Virology*.