complement each other's findings.

Adenovirus will probably turn out to have about thirty genes, and so far Dr Williams has arranged twenty-five temperature-sensitive mutants of Ad-5 into fourteen complementation groups and has shown recombination to occur. Genes for the fibre and hexon proteins have been marked with conditional lethal mutations. The mutant that does not make the fibre protein will undoubtedly prove invaluable in the purification of the penton because normally this cannot be separated easily from the fibre. Once purified, the fibre and penton base will then be amenable to biochemical studies into their precise function in cell infection or regulation of virus multiplication.

Several other complementation groups also hold great interest. Mutants of two complementation groups do not induce interferon production at restrictive temperatures when they infect non-permissive chick cells, and may therefore shed some further light on the mechanism of interferon production. Some complementation groups are involved in the maturation of virus particles in that they are implicated in the transport of viral proteins into the nucleus, where the virus is put together.

Adenovirus is able to transform cells in culture and one complementation group has been found to be essential for both virus multiplication and cell transformation. Furthermore, Dr Williams's group is looking at the ability of adenovirus-transformed cells to produce tumours in whole animals, but these studies are still very much in their infancy.

Completing the trio of viruses under major research at the Institute of Virology is vesicular stomatitis virus. VSV is an RNA virus of the bullet-shaped rhabdovirus group and causes mouth sores in cattle and horses. Dr Craig Pringle has isolated some three hundred temperature-sensitive mutants and has identified six complementation groups, and because VSV can be assumed to code for fifteen to twenty polypeptides, this represents approximately one-third of the genome. He and Dr Bill Wunner have shown that four of these six viral cistrons concern early functions because no viral RNA or protein is synthesized in restrictive conditions. Dr Josef Szylagyi and Dr Pringle have found that temperature-sensitive mutants of one of these groups possess a defective viral RNA transcriptase. Furthermore, although genetic recombination of the sort found in DNA viruses does not occur in this RNA virus, multiple temperature-sensitive mutants have recently been identified at the institute in the progeny of mixed viral infections. These are the first multiple temperature-sensitive mutants of any animal virus to be recognized. The institute was recently stirred into excitement when Drs Leonid Uryvayev and Josef Szylagyi succeeded in removing the coat protein completely from VSV ribonucleoprotein, retaining its full RNA transcriptase activity, for this should open up a highly productive avenue of research into the processes of VSV genomic expression by *in vitro* systems.

Out of these virus studies many clues to the strategy of the viral genome will rapidly accrue, but the staff of the institute are also doing important research into the genetics of the cell lines being used. In the long run, any statement of viral strategy must stem also from an understanding of the normal workings of host cells before they are manipulated by the virus genome. Indeed, the two lines of research should turn out to be complementary in that once the viral genome strategy becomes clear then much light may fall on the strategy of the cell genome.

CELL TRANSFORMATION

Surface Changes

from a Correspondent

WHAT happens when a normal cell becomes a cancer cell? If it is assumed that transformation of cells in tissue culture is indeed a close analogue of the malignant change, then at least there is considerable evidence that points to the importance of cell surface changes; new antigens appear, cells become more agglutinable by a variety of plant lectins and there are considerable alterations to the surface carbohydrate biochemistry on transformation. It has been known for some time that polyoma-transformed cells synthesize large amounts of mucopolysaccharide and that much of it is only loosely bound to the cell surface. Because it is quite likely that particularly successful tumours may sequester anti-tumour antibody by throwing off large amounts of surface antigen and therefore avoid direct immunological attack, it is clearly worth examining the material which is released from the transformed cell surface. A start on this has been made by Chiarugi and Urbano (*J. Gen. Virol.*, **14**, 133; 1972).

Chiarugi and Urbano have examined the glycoproteins released from the surface of the Syrian hamster cell line BHK21 and a polyoma transformed derivative of this line. Using radioactive glucosamine and amino-acids as labels, they fractionated the shed proteins on acrylamide gels, and claim that the transformed cell produces a component of molecular weight about 135,000 which is far more glycosylated than the corresponding membrane function of normal cells. Unfortunately it is not clear how recently the transformed derivative was obtained from the normal BHK cell line, so the differences they see may only indirectly be related to the transformation event.

A more careful study in this respect is reported in *Nature* (**235**, 275 ; 1972) by Warren *et al.*, and Buck *et al.* (*Biochemistry*, **9**, 4567; 1970) previously described a fucose-containing glycoprotein which is present in increased amounts in virus-transformed cells compared with normal cells. Warren *et al.* took advantage of the T5 Rous sarcoma virus mutant of G. S. Martin, and show that cells transformed by this temperature-sensitive virus possess the fucose-containing glycoprotein only at the permissive temperature—it disappears at the nonpermissive temperature. Cells transformed by wild type Rous sarcoma virus possess the glycoprotein at both temperatures. This therefore correlates with the difference in social behaviour that Martin has described for the T5-transformed cells at the two temperatures. At the permissive temperature cells are round and refractile and form colonies in soft agar whereas at the nonpermissive temperature they are elongated, grow in parallel array and do not grow in agar.

This work clearly supports the view that virus gene products directly change the cell surface and the cell's behaviour and it is of great importance to isolate these cell surface fragments from human tumours so that their shedding can be correlated with the prognosis of the disease in their hosts.

CORRESPONDENCE

Misinformation

SIR,—In the report (*Nature New Biology*, **234**, 258 ; 1971) on the Schering conference entitled "Exchanging Genetic Information" I have been quoted incorrectly. The spontaneous reversion rate from mouse HGPRT-deficient to HGPRT-positive cells was 2.5×10^{-8}. The highest reversion rate (30×10^{-8}) was indeed found in an experiment involving the addition of HeLa DNA, but this effect was by no means constant and clear cut when evaluated out of the whole series of experiments. The data mentioned are part of a study which is still in progress at the Albert Einstein College of Medicine in collaboration with Drs R. Caneva, S. Shin and K. Schildkraut.

Yours faithfully,

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