niques, he says, before he obtained his first retained graft. He has also maintained viable mouse jejunum, colon, stomach, and aorta tissues and mouse tumors in culture for extended periods, but has not successfully transplanted these. At least one other investigator in the United States and three in Europe have also duplicated some of his results, Summerlin says.

The cause of the phenomenon observed by Summerlin and the others is still virtually a complete mystery, but a minimum of five possible explanations have been offered:

► Some immunologists have suggested that the cultured skin, in which large numbers of cells have died, serves only as an inert matrix to support intrusive growth of the host's own cells. The primary evidence against such a possibility is Summerlin's observation that a successful skin graft can be removed from the host several months or years later and, without further culturing, can then be transplanted to either the original donor or a second recipient without rejection. (Jacobs has found that an accepted tumor can be transplanted to another member of the host's strain or to the original donor, but not to a mouse of a different strain.)

► Karasek thinks the most likely hypothesis is that the phenomenon involves the blood supply of the grafted tissue. Blood vessel cells, he argues, may be particularly labile in culture, so that acceptance of the grafted tissue would require the formation of new blood vessels in the graft. Revascularization of the tissue by the host would have the effect of prolonging the period during which the graft was initially exposed to the host's immune system, thereby preventing or delaying rejection of the graft. Both Karasek and Summerlin are performing experiments to determine whether the blood vessels of the accepted transplant are derived from the host or the graft. Revascularization will, however, likely also be rejected as an explanation if Summerlin's observation of the retransplantability of the grafts is verified.

► The histocompatibility antigens of the cultured tissue might be blocked or masked by some unknown substance that either is already in the culture medium or is produced by the cell during culture. Masking of the antigens would prevent the host from becoming sensitized during acceptance of the graft, but removal of the masking agent at a later date could lead to delayed rejection.

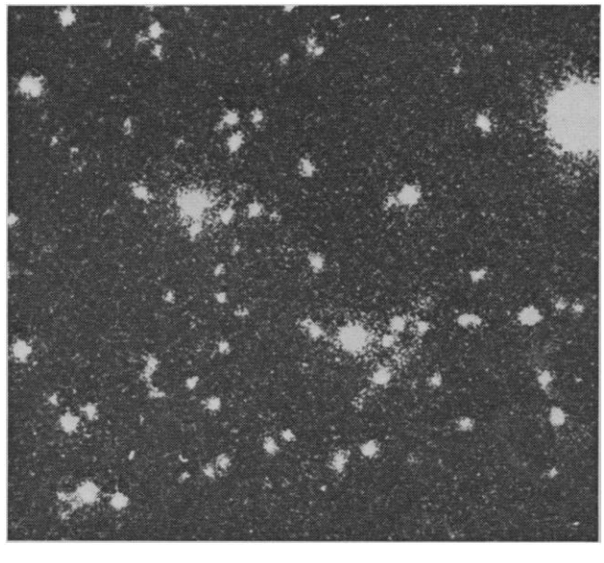
► Maintenance of the tissue in culture probably "washes out" the so-called passenger lymphocytes and other cellular components that might participate in sensitization of the host. This phenomenon, Summerlin says, might operate in conjunction with the revascularization of the graft.

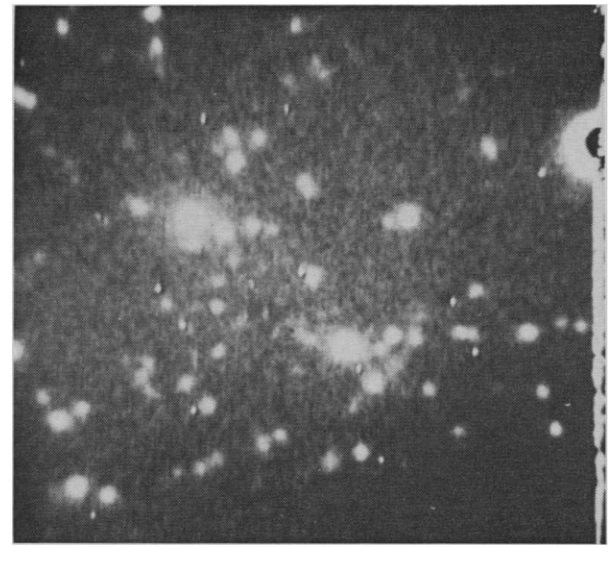
► Cultured skin cells, Summerlin says, superficially resemble the skin cells of embryos. It is thus possible that the cultured cells may be differentiating into a more primitive embryonic state in which they are unable to produce proteins, sugars, or other substances that might be recognized as foreign by the host. It is unclear how this type of differentiation would af-

Speaking of Science

Television-Type Sensors for Astronomy: New Pictures

At Mount Palomar, Mount Hamilton, Kitt Peak, and Mount Stromlo, indeed at almost every major observatory, astronomers are buying and testing television-type sensors. The small sensors alone cannot "see" very far, but the effect of attaching a sensor to a large telescope is to increase the telescope's effectiveness enormously. With this new bit of technology, the 200-inch telescope of the Hale Observatories could be made equivalent, for many purposes, to a 2000-inch telescope. In fact, because such great improvement can be achieved at relatively little cost with television sensors, the day of extremely large telescopes may be over. The most recently built U.S. telescope, dedicated on 20 June at the Kitt Peak National Observatory, has a mirror 158 inches (4 meters) in diameter and was built at about half the cost of a 200-inch instrument. With the exception of the





fect the functioning of larger organs.

There is, unfortunately, no biochemical evidence to support or reject any of these explanations. Summerlin reports that there are no other observable biological changes in the viable cells during the culturing, and that there are no gross changes in the culture medium. Investigators in his laboratory are now beginning a screening program to look for chemicals that might be shed by the cultured tissue, but this search is made difficult by the complexity of the culture medium—which makes identification of trace quantities of chemicals very laborious.

Confirmation and explanation of Summerlin's results could have great potential significance for the future of transplantation. Use of cultured tissues would, for example, provide a large new reservoir of skin for patients with burns and other superficial wounds, since skin from cadavers could be used routinely. Summerlin is now beginning studies with the Shriners Burn Institute in Cincinnati, Ohio, to explore this possibility. Culturing might also make it possible to store corneas and other simple organs for a much longer period of time than is now possible. An explanation of the phenomenon, moreover, might lead to a better understanding of the mechanism by which cancer cells are able to avoid stimulation of the body's immune system. But the potential for application of the technique to larger organs still remains questionable.

The most obvious problem is learning how to culture a large organ. Such organs are notoriously difficult to keep alive for any length of time. Isolated kidneys, for example, can be kept healthy by perfusion with blood or blood substitutes for no longer than 72 hours, by which time swelling of the endothelial lining of the blood vessels grossly restricts circulation through the organ. Total immersion of the organ in a culture medium might obviate this problem, but it would introduce the new problem of supplying internal tissues of the organ with sufficient oxygen. Summerlin's group is investigating techniques for culturing large organs, but their results, he says, while encouraging, are far too preliminary for comment.

Even if the organs can be cultured, other problems may arise. If the explanation of the phenomenon proves to be either intrusive growth by host cells or revascularization of the graft by the host, the culture technique would be patently unworkable for large organs. And if the explanation involves differentiation of the cultured cells to a more primitive state, it is quite possible that the transplanted organ would no longer be able to perform its function.

Transplantation of cultured tissue is obviously still at a germinal stage, and a great number of questions and problems remain. The most important problem, many immunologists argue, is confirmation that Summerlin's results are, indeed, valid. Beyond that lies explanation of the phenomenon and its application in clinical medicine. But the fruits of the continuing investigations promise to be very rewarding.

—THOMAS H. MAUGH II

Soviet Union, other countries constructing new telescopes are also building instruments with mirrors about 4 meters in diameter. (Five are planned.) An important element in the decision to build these telescopes on a smaller scale is the possibility of multiplying their light-collecting power many times with electronics.

The new sensors, which replace photographic plates in the operation of a telescope, are quite similar to the heart of a television camera in many cases, but are made of materials that are even more sensitive to low light intensities. The great advantage of television-type sensors is that they respond to as much as 90 percent of the light falling on them, whereas photographic plates typically respond to only 0.1 percent. The television-type sensors are also more effective at recording bright and faint objects side by side.

For about 2 years television-type sensors have been used to record the spectra of very faint objects, a process of recording data in essentially a one-dimensional form. But only recently have two-dimensional pictures been released for publication. The growth of research on the sensors has been rapid. A year ago there appeared to be only three systems actually ready to take data, but now there are many more. The excellent proceedings of a recent symposium at the University of British Columbia include 34 talks on different sensor systems (*1*).

Both pictures shown were made with the 200-inch telescope on Mount Palomar, as the telescope was pointed at a cluster of galaxies designated 0237 − 0138. To make the picture on the left, a photographic plate (103a-D) was placed at the prime focus of the telescope and exposed for 50 minutes. When the plate was replaced with an SIT (silicon intensified target) vidicon at the focus, only a 6-minute exposure was needed to make the image on the right. The vidicon picture appears worse on first viewing because it is fuzzier, but it actually contains more information than the photograph on the left. Because photographic plates have a threshold, the wispy outer parts of the galaxies do not show up in the photographic image. This deficiency for recording all the light that falls on the plate gives hard edges to the image and produces a pleasing picture, but important fine details are lost.

The image from the SIT vidicon is recorded directly onto magnetic tape in numerical form and simultaneously displayed on a small television so that the astronomer can see his picture immediately. All the electronics for the system, including a tape recorder that is compatible with a large computer, fit neatly into a compact 120-pound unit that rides aloft with the observer near the top of the telescope. The device was developed by James Westphal of the California Institute of Technology, Pasadena, California, and Hale Observatories.

Other types of vidicons are also being developed, and solid-state systems utilizing charge-coupled devices may soon be perfected to the point where an entire sensor, including a preamplifier and switching circuitry, can be contained on a thin piece of silicon. New sensors have already provided data on distant quasars that probably could not have been obtained any other way, and now that high-quality pictures can be made with electronics, the technology of television may revolutionize astronomy.

—WILLIAM D. METZ

References

1. Copies of the symposium, Astronomical Observations with Television-Type Sensors, 15–17 May 1973, are available for $10 from the Institute of Astronomy and Space Science, University of British Columbia, Vancouver 8, Canada.