SCIENCE

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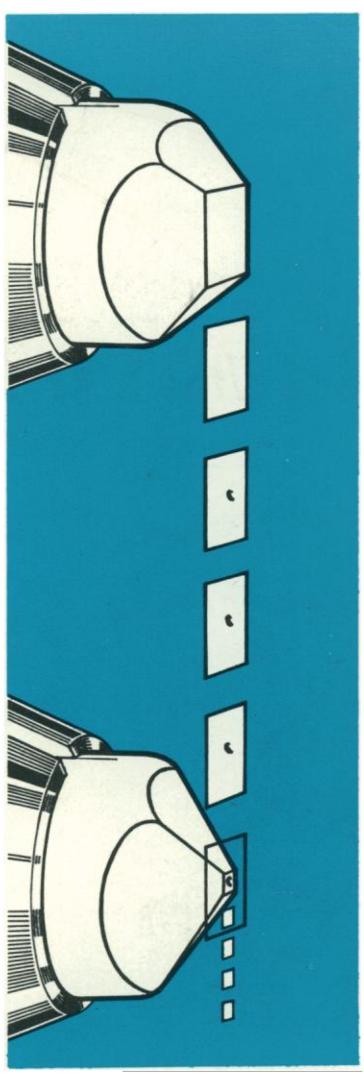

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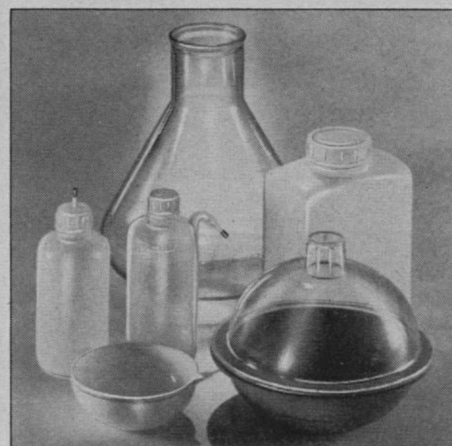

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COVER

Conjoined pair of leopard frogs (*Rana pipiens*) that had been united in parabiosis in early embryonic development (60 hours after fertilization). The copartners are blood cell chimeras and are immunologically tolerant of each other's blood antigens. See page 850. [E. Peter Volpe and Elizabeth M. Earley, Tulane University]

Concepts from Union Carbide:

Cryogenic freezing of red blood cells

Probably no single problem has received more attention from cryobiologists than the preservation of the human red cell. And with good reason. Procedures that extend the supply of erythrocytes for transfusion have meaning in terms of human lives.

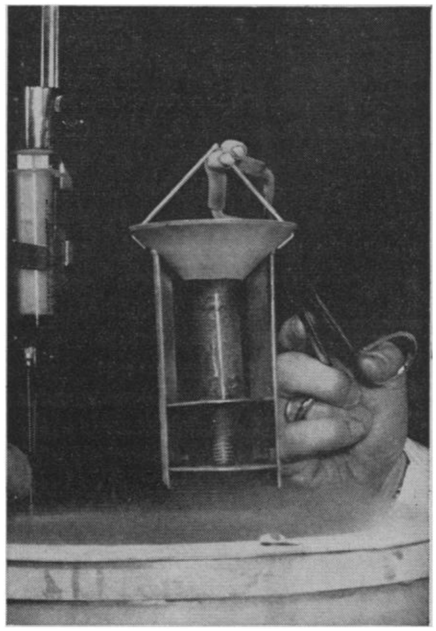
The prospect of a frozen blood reserve has been a matter of intensive interest to the blood banking agencies for the past twenty years; some have played a major role in the scientific attack on the problem. It has not been easy. It was observed in 1941 that red cells (suitably protected with additive substances) could survive the drastic environmental changes induced by freezing. Since then, processes have been sought for the preservation of blood in the frozen state that would provide a useful and acceptable product for transfusion. As evidenced over the past decade by the successful transfusion of thousands of units of blood preserved in the frozen state, that goal seems to have been reached.

The current limitation of twenty-one to twenty-eight days for blood preserved by conventional methods in the liquid state has often taxed the resources of the organizations that undertake to provide our communities with supplies of this indispensable agent. The relatively short shelf life of the cellular components of blood adds to the problem of coordinating supply with demand. The less common blood types sometimes are difficult to procure, but even the more common types may vary in supply at any given time.

Red cell wastage is an inevitable consequence of the dating period necessarily imposed on blood stored at 4°C. A primary objective of agencies interested in preserving blood at low temperatures is to prevent this wastage. Another, of course, is to assure adequate reserves of all types of blood at all times for each community. Conceivably then, as frozen blood banks become established in various parts of the country, an integrated and computerized inventory system could be developed that would result in an effective national reserve.

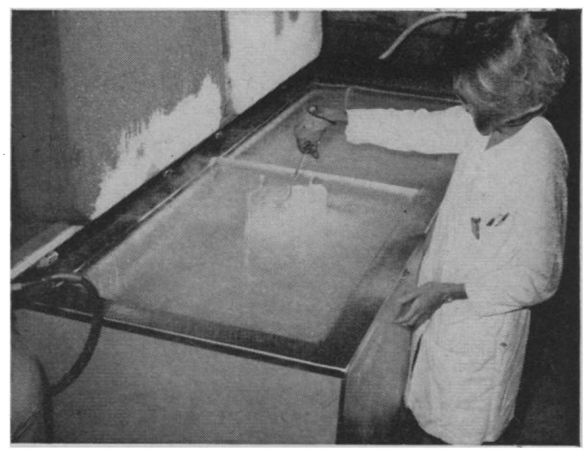
Several practical approaches to the preservation of blood at low temperatures have evolved. All have some elements in common. A solution of additives, often called cryoprotective agents—glycerol is the outstanding example—is combined with the red cells from which most of the plasma and much of the other cellular components of blood (leukocytes and thrombocytes) have been removed. This is done in special containers in which the erythrocytes are cooled and placed in long-term storage. When needed, the erythrocytes are withdrawn from storage, warmed, and subjected to a washing procedure to remove the protective agent before transfusion.

The heart of a frozen blood reserve is the storage facility. Storage equipment is of two general types: cryogenic and noncryogenic. The latter provides temperatures down to about −85°C and depends on electric power. The cryogenic equipment is independent of a power source and provides lower storage temperatures—down to −196°C—with liquid nitrogen, the most commonly used refrigerant. Associated with such storage equipment are cryogenic shipping units that permit transport of blood in the frozen state without danger of a destructive rise in temperature that might render the blood cells unfit for transfusion.



Small quantities of blood are instantly frozen for long-term storage in the droplet freezer. A mechanically vibrated syringe releases droplets into a revolving drum of liquid nitrogen. The frozen droplets are collected in the base. Thousands of droplets can be collected from each sample for use as reference specimens.

The banking of frozen blood with longer shelf life should considerably enhance the ability of the blood supply agencies to meet demand and might influence current procurement practices. The use of cryogenic storage equipment would provide a margin of safety for autologous blood banking in which individuals of rare blood type would establish a reserve of their own blood in anticipation of later need. Probably most important in terms of medical need, the availability of banks of frozen red cells would seem likely to lead to the development of banks of the other cellular components of blood. With current liquid state storage procedures, platelets and leukocytes—far less stable than the red cell—are without transfusion value within about three days or less after donation. At present, the only prospect for establishing a large-scale reserve of these invaluable components is to preserve them in the frozen state. Although low temperature preservation procedures for these cells are not technically as far advanced as for the red cell, several blood laboratories are fully aware of the need and are attacking the problem vigorously.



The refrigerator shown here stores red blood cells for transfusions. No other cryogenic refrigerator provides as much storage capacity in as little space as the LINDE LR-1000.

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Strategic Postures

In "Strategic arms talks: What is negotiable?" (27 Mar., p. 1707), Andrew Hamilton mentioned the three negotiating strategies discussed by President Nixon in his foreign policy message on 18 February. Hamilton correctly identified the third as reducing offensive forces, but he added: "It is notable that the President did not mention restrictions on defensive weapons such as the ABM in the third approach. One school of strategists, led by Herman Kahn and Donald Brennan of the Hudson Institute, has for several years advocated a 'defense race' as a more stable form of competition than an offense race."

It is correct that I have been advocating a substantial shift in emphasis to defense, as opposed to offense. . . . But, in associating my views with the President's third strategy, I believe Hamilton read into the strategy an association that was not intended. In the President's message, after he listed the three categories of negotiations (the "strategies"), the paragraph immediately following the third reads: "Each of these options was analyzed in relation to various levels of strategic defensive missiles, ABM's." It is quite clear that this was intended to apply to the third strategy no less than the other two.

I have favored shifting emphasis from offense to defense not so much because it would provide "a more stable form of arms competition than an offense race," indeed there are few senses in which a "more stable" situation would be a likely outcome, but first and foremost because it could save enormous numbers of lives, and save important resources to support the survivors, in the event a war actually occurred. [There are other important reasons as well (*1*).] I am quite willing that a suitable shift in emphasis should reduce Russian lives at risk no less than American, and I do not intrinsically favor a "defense race" to bring this about.

There has been a major revolution in the technology of active defense in the past 6 or 7 years, and this makes it possible to favor live Americans in preference to dead Russians in the procurement of our strategic forces and in our arms-control objectives. We should encourage the Soviets to exercise a similar preference—which they should find natural—for live Russians in preference to dead Americans. These preferences would be ill served by limiting defenses to very low levels, or zero, although an all-out defense race is not needed either. What is needed is a ceiling on offensive forces, or better yet, substantial reductions in offensive forces, coupled with the deployment of significant defenses. In general terms, at least, a posture of this type could be developed within any one of the three general categories mentioned in the President's message. Whether it will be, of course, remains to be seen.

D. G. Brennan
Hudson Institute, Croton-on-Hudson, New York 10520

References

1. D. G. Brennan, in *Why ABM?*, J. J. Holst and W. Schneider, Jr., Eds. (Pergamon, Elmsford, N.Y., 1969); ———, in *Safeguard: Why the ABM Makes Sense*, W. R. Kintner, Ed. (Hawthorn Books, New York, 1969).

Society of Ciphers

Joseph V. Smith is worried regarding the invasion of his privacy by the use of his social security number (Letters, 13 Mar.). I suggest that he relax since the privacy of an individual to all intents and purposes ceased with the passage of the Federal Income Tax Amendment in 1913. . . .

William H. Bell
R.F.D. Box 417, Milford, Ohio 45150

In looking through my billfold, I find the following frequently used identification cards, each of which bears a different number: eight credit cards of various kinds, driver's license, firearm owner's registration, private pilot's license, and two insurance company identification cards. In addition, there are at least a dozen other identity numbers which I use on rarer occasions.

The reason for these numbers is the ambiguity of one's name. If we had a system of naming people which would insure no duplication, we would need no numbers, although for data processing purposes the numbers are undoubtedly more convenient. Surely no one would object to having a unique name. Why then an objection to a unique number? Assuming that a unique number is desirable, why not then have only one per person, rather than dozens? The social security number is unique and serves well for identification. The sooner we can persuade our licensing and accrediting agencies to adopt the one number, the more convenient it will be for the individual.

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The Changing Job Market

Recently, *Science* had an opening for a proofreader. Among the applicants was a Ph.D. in physics, who had been engaged in space research. Our interviewer, feeling that the applicant was overqualified, named a low salary. The physicist still wished to be considered; he said, "That would feed me." Further examples of an anecdotal kind are easily obtainable. They lead to the impression that scientists are experiencing unusual difficulty in finding positions commensurate with their training.

Detailed, up-to-date quantitative evidence on the job market for scientists is scarce. One of the best recent studies was conducted by Mrs. Susanne Ellis* for the American Institute of Physics (AIP). She examined the placement of new Ph.D. physicists during the past 3 years. The study confirmed that applicants are working harder to find jobs. In 1969, 52 percent of candidates sent applications to ten or more potential industrial employers. This figure was up from 29 percent in 1967. At the same time, the number of applicants whose efforts produced no offers rose sharply. The survey revealed that 2.5 percent of the recent doctorate holders are unemployed. But that percentage is deceptively low because, of the 1969 physics Ph.D. graduates, 46 percent have accepted temporary postdoctoral appointments. This figure is up from 6 percent in 1959 and 25 percent in 1967. Most of these temporary appointments were created by the chairmen of physics departments for their own Ph.D. graduates.

The dark picture for physicists has its origins mainly in changes on the academic scene. During the period of exponential growth of federal support, the number of positions available on university staffs increased in spite of a lack of growth in the number of physics undergraduates. This increase in faculties absorbed most of the new Ph.D.'s. When federal support leveled off, physics departments could not justify additional appointments to their staff. Industry and government, which together had been employing about 30 percent of the new Ph.D.'s, could not absorb the surplus. The kind of training that physicists have experienced is partly to blame. The AIP survey reported that nonuniversity employers found that physicists were overspecialized and less adaptable than engineers. Engineers have been obtaining an extensive physics education as part of their engineering training and are now taking positions that formerly went exclusively to physicists.

In part, the employment problems of physicists represent a crisis of expectations. The AIP survey asked recent doctorate holders to name their desired employer. As many as 57 percent named universities (where there are few job openings), whereas only 4 percent named government and almost none named 2-year colleges. The 2-year colleges employ only 1 percent of new Ph.D.'s and could use many more.

An article to be published in *Science*† sets forth results of a survey of many fields conducted by the National Research Council. The survey confirms the finding that most new Ph.D.'s must work harder to find jobs, but differs from the AIP study in its assessment of the extent of unemployment among new Ph.D.'s. The Council report is much more cheerful.

Faced with the possibility of an excess of scientists, the Nixon administration, in its 1971 budget, proposes to cut in half the number of new fellowships and traineeships (*Science*, 1 May). Earlier years have already seen severe pruning of such support. The proposed cuts will have repercussions extending to the high schools, and the full effects will endure for decades. Blinded by the prospects of short-term maladjustments, the administration seems about to stumble into long-term destruction.—PHILIP H. ABELSON

* Susanne D. Ellis, speech presented at the Amercian Physical Society Meeting, Washington, D.C., 28 April 1970. † Office of Scientific Personnel, National Research Council, "Employment status of recent doctorate recipients," *Science*, in press.

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glacial sequence is covered disconformably by a widespread Silurian transgression, shales with graptolites. This involves a curious contradiction to traditional ideas of the meaning of graptolitic shales, usually taken to be a deep-water facies with a pelagic fauna. Fairbridge pointed out that there were two sorts of transgression (apart from those involving crustal movement): eustatic and geoidal. A glacio-eustatic rise would only be expected to replace the water glacially removed from the ocean, but an important polar shift would call for a readjustment of the geoid, that would be instantaneous in the case of the ocean, while the crustal adjustment would be quite slow. The Silurian transgression seemed to be one of the second type. As observed in the field, the sub-Tassili (that is, pre-Ordovician) erosion surface lacks major conglomerates, but is marked by small quartz gravels, often "eolized," even with some small "dreikanters." The underlying Precambrian is chemically weathered and leached to a depth of 3 to 4 meters and is capped by a residual hematitic crust or paleosol. Bogdanov pointed out that the age of the last major folding in the shield hereabout was 1.5 to 1.6×10^9 years, but there were some dates indicating 4 to 5×10^8 years. The latter were clearly incompatible with the fossil and structural evidence of unwarped Ordovician.

It is interesting that there is widespread evidence of eolian conditions just prior to the Ordovician in north Africa [a subpolar(?) desert, for example, Gobi], and there is also a widespread Eocambrian glaciation. It seems likely that the hematitic crust (residual lateritic paleosol) and bleaching are relics of seasonably warm wet weathering conditions from well back in the Precambrian. In this environment a semiarid pedimentational history could well have been the last important event before the arid conditions descended. Percy Allen pointed out that wherever we saw the contact there were no fragments of the underlying basement in the transgressive Ordovician pebble conglomerate, which suggested a long intervening period of subaerial history associated with a great climate change. De Charpal noted that the kaolinitic weathering observed by us east of Hoggar became gradually replaced by illite farther to the northwest; this might suggest a late Precambrian pole position still farther to the northwest.

Paul Potter (University of Indiana) presented a clear analysis of the geometry of the sand bodies, emphasizing the distinction between the piedmont fan type that thins distally and paralic type that thins landward. Jean-Philippe Mangin (University of Nice) stressed the unusual relationship in the Ordovician glacials where both the underlying beds were sandstones and so were the tillites. Indeed it seems clear that often the only major difference in lithology was that the underlying sands were frozen, and therefore temporarily "lithified" by permafrost, while the overlying tills were mostly laid down during retreat stages; then, after total deglaciation, the slight differences between "bedrock" and "drift" require very close inspection. Fairbridge questioned the "fluviatile" interpretation of some of the "bedrock" (Ordovician) sands. It was not enough to find them unfossiliferous (actually, they are not), but the structure, granulometry, and gross distribution must be considered. Mixture with both eolian and marine conditions must be regarded as normal. Statistically the chances for continental preservation are always less than for marine. In desert regions such as eastern Saudi Arabia, the desert dune sands (that started as fluvial sands) are regularly dumped onto the beach by the westerly winds and then they are redistributed as offshore bars. Many of the so-called "eolian" sandstones of the American West are regarded by Fairbridge as marine, although the grains may well be "eolized." In the case of the Saharan Ordovician the near-parallel division of most of the cross-bedded units (and the less-than-25-degree dips) speak for a marine setting. The current is systematically north to northwest, which seems to be general paleoslope of the craton, followed later by the ice, and later still by the outwash sandurs. João José Bigarella (University of Paraná, Brazil) confirmed that the structural form of most of the cross-bedding (except in the glacial outwash) was marine.

Adolf Seilacher (University of Tübingen, Germany) demonstrated how he found fossils or tracks of trilobites and traces of other marine life systematically almost through the entire mid-Saharan Ordovician section. The fossils suggest that the glaciation was in or immediately followed the Upper Caradocian. These observations offered further confirmation that the cross-bedding was marine and that the continental glaciers came down to form ice shelves comparable, say, with those of the Ross Sea and the Weddell Sea today.

The last session was devoted to talks