bromine inhibition than is the formation of aminoacyl-RNA. Thus, when transfer RNA is brominated with 2 bromine atoms per 80 nucleotide residues of transfer RNA, there is 18 percent inhibition of the formation of phenylalanyl-RNA, 30 percent of valyl-RNA, and 58 percent of lysyl-RNA. At this degree of bromination, there is no inhibitory effect on the transfer of these amino acids to the ribosomes. The absence of damage at low levels of bromination is consistent with a multihit inactivation curve for the donor function. When the degree of bromination is greater (8 bromine atoms to 80 nucleotides) there is 60 to 75 percent inhibition of the formation of the 3 aminoacyl-RNA's studied, while there is only 12 to 27 percent inhibition for the transfer of the same amino acids. Thus it appears that the formation of aminoacyl-RNA's requires a larger undisturbed region on the RNA molecule than that required for the transfer of the same amino acids to the ribosomes. These observations strengthen the concept that the two biological functions of transfer RNA—namely, the acceptance of activated amino acid and the transfer of the amino acid to the ribosomes—are carried out by different structural sites on the transfer RNA molecules. It is possible that these sites overlap but they appear not to be identical.

There is an interesting parallel between the effects of bromination and those of biological methylation with respect to transfer RNA. In both cases the recognition-acceptor function is more sensitive than is the coding-transfer function. The explanation may lie in the greater dependence of the recognition-acceptor site on the presence of an intact secondary structure.

A degree of caution in the foregoing interpretations of the data arises from several considerations. In theory, one delineates "recognition-acceptor" and "coding-donor" areas of the transfer RNA molecules as though the remainder were nonspecific and common to all. Except for the common –CCA ending, however, existing evidence suggests that the nucleotide composition and sequence of each molecule may be unique. Thus bromination may affect each species of transfer RNA molecule differently, owing to unknown influences on secondary structure resulting from the different arrangement of sequence of the bases in each individual type of aminoacyl-RNA molecule. As previously mentioned (*4*), there is also the underlying assumption that the bromination is independent of single- or double-strandedness. The degree of methylation of the minor bases may also be an influence that modulates the effect of bromination. Finally, in a heteropolymeric nucleotide, bromination may weaken or alter, without abolishing, the hydrogen bonding in a localized site.

When approximately 20 percent of the pyrimidine residues (or 10 percent of the total nucleotide residues) of the transfer RNA are brominated (Table 3) for any particular pyrimidine residue, the probability of being brominated is 20 percent. At this degree of bromination, the inhibitory effect on the transfer of both valine and phenylalanine is about 30 percent. The "anticodon" of valine (AAC) contains a pyrimidine residue, and that of phenylalanine (AAA) does not. In order to fit with the base-pairing hypothesis, one has to assume that this 30 percent inhibition of valine transfer is largely due to a direct hit on the transfer site, while in the case of phenylalanine, it is entirely due to indirect, conformational change of the transfer RNA molecules. Although this assumption may not be unreasonable, it seems that positive experimental evidence is needed to substantiate the base-pairing mechanism of the adaptor hypothesis.

CHUAN-TAO YU
PAUL C. ZAMECNIK
John Collins Warren Laboratories, Huntington Memorial Hospital of Harvard University, Massachusetts General Hospital, Boston

References and Notes

1. M. B. Hoagland, P. C. Zamecnik, M. L. Stephenson, *Biochim. Biophys. Acta* **24**, 215 (1957).
2. Abbreviations: -cytidylyl-cytidylyl-adenosine (-CCA), polyuridylic-guanylic acid (polyUG), polyuridylic acid (polyU), polyadenylic acid (polyA), -uridylyl-uridylyl-uridylyl- (UUU), -uridylyl-uridylyl-guanylyl- (UUG), -adenylyl-adenylyl-adenylyl- (AAA). TCA, trichloroacetic acid.
3. C.-T. Yu and P. C. Zamecnik, *Biochim. Biophys. Res. Commun.* **12**, 457 (1963).
4. ———, *Biochim. Biophys. Acta* **76**, 209 (1963).
5. L-Valine-1-C^{14} and DL-phenylalanine-1-C^{14} were kindly supplied by R. B. Loftfield. L-Lysine-C^{14} was purchased from Schwarz BioResearch, Inc.; transfer RNA from General Biochemicals, Chagrin Fall, Ohio; the copolymers polyUG, and polyU, and polyA from Miles Laboratories, Elkhart, Ind.
6. R. B. Loftfield and E. A. Eigner, *Acta Chem. Scand.* **17**, *Suppl. 1*, 117 (1963).
7. ———, *Federation Proc.* **23**, 164 (1964).
8. G. Felsenfeld and A. Rich, *Biochim. Biophys. Acta* **26**, 457 (1957).
9. R. B. Inman and R. L. Baldwin, *J. Mol. Biol.* **5**, 172 (1962).
10. A. M. Michelson, in *The Chemistry of Nucleosides and Nucleotides* (Academic Press, New York, 1963), pp. 449–450.
11. G. L. Brown and G. Zubay, *J. Mol. Biol.* **2**, 287 (1960).
12. S. P. L. Sarin and P. C. Zamecnik, unpublished data.
13. D. Nathans and F. Lipmann, *Proc. Natl. Acad. Sci. U.S.* **47**, 497 (1961).
14. O. W. Jones and M. W. Nirenberg, *ibid.* **48**, 2115 (1962).
15. S. Ochoa, in *Aspects of Protein Structure*, G. N. Ramachandran, Ed. (Academic Press, New York, 1963), p. 147.
16. M. L. Stephenson and P. C. Zamecnik, *Proc. Natl. Acad. Sci. U.S.* **47**, 1627 (1961).
17. Supported by grants in aid from the U.S. Atomic Energy Commission, the American Cancer Society, and the U.S. Public Health Service. Publication No. 1153 of the Cancer Commission, Harvard University. We thank Robert B. Loftfield, Mary L. Stephenson, Jesse F. Scott, and Marvin R. Lamborg for helpful criticism.

4 February 1964

Radioactivity Measurements in Alaskan Eskimos in 1963

Abstract. *During the summer of 1963 people at five villages above the Arctic Circle in Alaska were measured for accumulated radioactivity with a portable whole-body counter. Adults of the interior village of Anaktuvuk Pass showed the highest average body burden, 628 nanocuries of cesium-137. This is an increase of nearly 50 percent over the summer before. The maximum burden found was 1.24 microcuries.*

Measurements with a portable whole-body counter during the summer of 1962 showed that Eskimos in northern Alaska had accumulated more fallout Cs^{137} in their bodies than people in other parts of the United States (*1*). These high concentrations resulted primarily from the food chain, lichen to caribou to man (*2*). Lichens contain more Cs^{137} than most food-chain components because their long lifetime permits more accumulation. New measurements made during the summer of 1963 showed continued high and generally increased accumulations of Cs^{137}. The increases were probably associated with new fallout resulting from resumption of weapon testing late in 1961.

Table 1 compares results obtained during 1962 and 1963. The same counter was used both years; during 1963 the counter was also calibrated for Cs^{137} in children (4 through 14 years) so more young people were measured. Measurements were made at Fort Yukon as well as at the villages visited in 1962.

The adult Eskimos (15 years and older) at Anaktuvuk Pass showed a nearly 50 percent increase in average body burden of Cs^{137} over 1962. Everyone counted during both years showed

Table 1. Body burdens of cesium-137 (in nanocuries) in permanent Eskimo residents of Alaskan Eskimo villages.

Adults*				Average for children†
Average		Maximum		
1962	1963	1962	1963	1963
		Anaktuvuk		
421	628	790	1240	217
		Kotzebue		
138	140	518	732	42
		Barrow		
52	60	166	177	19
		Point Hope		
17	39	119	88	17
		Fort Yukon		
	34		181	13

* 15 years or older. † 5 to 14 years.

increases that ranged from 5 to 112 percent. The average percentage increase was less than that shown by people counted at Richland, Washington, who showed an average of 6 nanocuries in 1962 and 12 nanocuries in 1963. The food chains controlling the Cs^{137} of the people in Washington are, of course, much different from those for the Eskimos. A man from Anaktuvuk Pass had the highest amount of Cs^{137} found, 1.24 microcuries.

The International Committee on Radiological Protection (ICRP) recommends that the maximum permissible body burden of Cs^{137} be set at 3.0 μc for individuals in the population at large who are not exposed to radiation in the course of their occupation (*3*). No specific recommendation was made concerning permissible average body burdens of Cs^{137} for groups such as the Alaskan Eskimos.

Cesium^{134} was again present in the Eskimos in 1963 (*4*). In the ten Eskimos with the most Cs^{137}, the Cs^{134}:Cs^{137} ratio decreased from 0.012 in 1962 to 0.0067 in 1963; the actual amount of Cs^{134} decreased by 22 percent. This indicates that the composition of the fallout was changing, presumably because of the arrival of new material from nuclear tests that started in 1961. If the new material contained no Cs^{134}, and if the Eskimos were in equlibrium with the old fallout, the amounts of Cs^{134} in the Eskimos would have decreased by 28 percent, nearly the percentage observed. The fact that Cs^{134} was picked up on an air filter at Richland, Washington, in January 1963 with a Cs^{134}:Cs^{137} ratio of 0.016 may indicate that the fallout in Alaska and in Washington came from different tests.

The change in the Cs^{134}:Cs^{137} ratio indicates that the increases found at Anaktuvuk Pass were associated with new fallout material. It is improbable that any significant part of the increases were the result of more caribou having been eaten since it is a principal item in their diet and it is relatively available at all times of the year because carcasses are stored in permafrost pits. Furthermore, those people tested for radioactivity indicated that they had eaten about the same amount of caribou in 1962–63 as in 1961–62. The large increase in the Cs^{137} in the people at Point Hope resulted largely from a poor harvest of caribou in 1962 and a good one in 1963. People at Kotzebue were tested about 2 months later in 1963 than in 1962. Since their diet contains less caribou meat in the summer, they may have eliminated some of the Cs^{137} they had accumulated; earlier testing might have shown a significant increase.

Urine samples obtained during the winter of 1962–63 through the U.S. Public Health Service hospital at Fort Yukon were examined for Cs^{137}. The results indicated an average body burden of about 120 nanocuries. This was of particular interest because the main meat in the diet came from moose, which indicated another food chain of interest. For these reasons the Athapascan Indians at Fort Yukon were examined in 1963. A period of approximately 4 months, months in which there was little caribou or moose meat in their diet, is presumed to be the cause of the difference between the 34 nanocuries observed by counting and the 120 indicated by urinalysis.

HARVEY E. PALMER, WAYNE C. HANSON
BOBBY I. GRIFFIN, DALE M. FLEMING
Hanford Laboratories, General Electric Company, Richland, Washington

References and Notes

1. H. E. Palmer, W. C. Hanson, B. I. Griffin, W. C. Roesch, *Science* **142**, 64 (1963).
2. W. C. Hanson, H. E. Palmer, B. I. Griffin, *Health Phys.*, in press.
3. International Commission on Radiological Protection, *Report of Committee II on Permissible Dose for Internal Radiation* (Pergamon, London, 1959).
4. H. E. Palmer and R. W. Perkins, *Science* **142**, 66 (1963).
5. We thank Kasume Kasugi of the U.S. Public Health Service for use of the hospital facilities at Kotzebue and Barrow and Max G. Brewer, director of the Arctic Research Laboratory, for invaluable support in transporting equipment at Barrow and Anaktuvuk Pass and the use of the laboratory facilities. This work was performed under contract No. AT(45-1)-1350 between the Atomic Energy Commission and General Electric Company.

6 March 1964

Carbon Monoxide Production by a Bathypelagic Siphonophore

Abstract. *A physonectid siphonophore,* Nanomia bijuga, *associated with a vertically migrating deep scattering layer, has been observed with a gas-filled float at depths in excess of 300 meters in the sea. This implies that gas is secreted and maintained in the pneumatophore against a diffusion gradient of 30 atmospheres or more. Analysis of the enclosed gases revealed concentrations of carbon monoxide exceeding 90 percent. Necessary voiding of this gas during a vertical ascent of 300 meters could give rise to a transient population of bubbles which would act as sound-reflecting targets.*

Deep scattering layers (DSL) are zones of sonic reverberation occurring at depths of several hundred meters throughout much of the ocean. A component of each layer usually migrates vertically each day, rising toward the surface at sunset and descending again before sunrise. Current theory holds that a major source of acoustic scattering from such migratory layers is resonant gas bubbles, for example, the swim bladders of fishes (*1*). Another important source recently suggested is the gas-filled floats (pneumatophores) of siphonophores (*2*) (Fig. 1), which are colonial coelenterates. The physonectid type consists of a highly contractile stolon, which bears an apical pneumatophore followed by a cluster of swimming bells and linearly arranged polyps modified for capturing and consuming prey and for sexual reproduction.

One species, *Nanomia bijuga* (*3*), was observed directly from the U.S. Navy bathyscaph, *Trieste*, at the exact levels of the deep scattering layers during dives in the San Diego Trough (*2*). These observations showed that nanomians are capable of vigorous and rapid swimming. The hauls from our nets indicate that these organisms may move vertically some 300 m in an hour or less. To keep the pneumatophore inflated at the lower end of its vertical range, its gas content must be maintained against a diffusion gradient of some 30 atm (*4*). We have attempted to learn the nature of the gases enclosed and how they are maintained under these extraordinary conditions.

The organism (colony) becomes badly fragmented when captured by our automatic opening-closing net even when