termined exactly what prevents the gas from reaching vascular tissue.

To test their premise they first found, in artificial blood, that slight protein increases reduced oxygen transport by as much as 60 percent even though the amount of protein in the fluid would be considered within the normal range for human blood. Then for a period of six months they put adult male rabbits on normal diets, high cholesterol diets, high protein diets or high cholesterol-protein diets. The cholesterol was taken orally by the animals; the proteins were injected. "We used rabbit proteins to avoid an immune response," Dr. Gainer explains, "and injected the protein rather than give it orally since most proteins in the bloodstream are not derived from dietary protein. Sixty percent of bloodstream protein, for example, is albumin, which is made in the liver. Another 15 percent is gamma globulins, of uncertain origin but probably not dietary-derived."

Gross observation and pathological analysis of tissue samples from the rabbits showed that those on high cholesterol diets had thicker blood vessel walls than those on normal diets; rabbits on protein diets had thicker walls than those on high cholesterol diets; and those on protein-cholesterol diets had the thickest walls of all. In other words, as the protein content of the rabbits' plasma increased, the oxygen decreased and the vital furrows and bridges on the inner lining of the blood vessels collapsed, being replaced by smooth ones. "It is in these smooth areas that scientists believe fat deposits characterizing atherosclerosis build up," Dr. Gainer says.

The real clincher though, he stresses, is three-dimensional pictures of the inner aorta wall from various tissue samples that he and Chisholm took with a scanning electron microscope. "The photos," Dr. Gainer explains, "show that the furrows lining the aorta of animals on normal diets tend to disappear in the aorta of animals on high protein, especially high protein-cholesterol diets."

Univ. of Va.

Gainer: Furrows inside normal aorta.

What this means to current dogma about hardening of the arteries is far from clear. The bulk of evidence to date, based mostly on lipid studies, suggests that the amounts of two of the three kinds of lipids found in the blood are influenced by diet, and that a high blood content of these lipids often means susceptibility to hardening of the arteries.

Dr. Gainer and Chisholm believe, on the basis of their work, that protein is implicated in atherosclerosis, if it is not the cause of it, but that the protein in question does not derive from dietary protein. Dietary control of protein therefore would have little effect on preventing the disease.

A physician-researcher at the National Heart and Lung Institute, only cursorily familiar with the Virginia work, asks whether oxygen deprivation in the blood and subsequent hardening of the arteries might not be related more to lipoproteins than to proteins. To which Dr. Gainer replies: "I imagine concentrations of any long polymeric material, whether albumin or a lipoprotein, would produce similar effects. We have investigated only those proteins which are present in the blood in large amounts—not specific proteins."

Dr. Gainer and Chisholm are now screening drugs to find one which might possibly increase oxygen transport to arterial walls and counter blood proteins' tendency to prevent that transport. □

LEARNING THEORY

A head start for logic

A widely held learning theory is that young children are unable to form transitive inferences about quantity until they are approximately seven years old. That is, if a child is taught that A is larger than B and B is larger than C he cannot infer from this information that A is larger than C. This theory, if true, implies that the necessary logical structures for this type of inference are absent or underdeveloped before the age of seven, the age of logical perceptions.

Researchers P. E. Bryant of Oxford University and T. Trabasso of Princeton University do not completely agree with this view. The complex deductions involved in language learning, which children do before the age of seven, imply "incredible inferential capacity," says Trabasso. Therefore, they designed two experiments to demonstrate that four-, five- and six-year-old children can make "transitive inferences about quantity, provided that they can remember the items of information which they are asked to combine."

The experimenters concentrated on memory and perception rather than logic as the important factors in the learning process. "One must ensure that the child has retained the comparisons which he has to combine, if one is to infer whether or not he can make transitive inferences. Otherwise, an error might simply be due to a failure in memory and have nothing to do with inferential ability," they write in the Aug. 13 NATURE.

First the child was taught the comparisons (A is larger than B, B is larger than C, C is larger than D, etc.) thoroughly. Then he was tested for memory of these comparisons at the same time he was asked the inferential questions about A and C. This was to ensure initial retention of the information and retention during the inferential process.

Sixty children, ages four, five and six participated in the first experiment. They were shown the tops of five wooden rods, each of a different length and color. Previously they had been taught that rods of different color were of different sizes (three, four, five, six and seven inches). And then, to test them for retention of this information, they were asked to indicate which rod was the taller or shorter. After the child chose, the experimenter showed the child the entire length of the rod so that direct comparisons could be made. Then the child was tested on his ability to make logical inferences about the various lengths of the rods and, "the evidence for transitivity was impressive at all ages," the researchers report.

A second experiment on 25 four-year-olds and 25 five-year-olds was carried out without the visual feedback. During initial learning the child was simply told (not shown) which rod was longer after he made his choice. This ensured that the problem was solved by genuine transitive inference—rather than by simply remembering visually the lengths of the various rods. "Once again performance on all transitive comparisons was well above chance."

The researchers do not know whether these findings are general or only applicable in this instance and they do not know at what age this logical ability develops because they have not tested younger children. But Trabasso explains that this ability is often hidden by other processes. And they conclude: "The last experiment conclusively demonstrates that very young children are able to make transitive inferences extremely effectively. They can combine separate quantity judgments very well and they can do so at a far younger age than has generally been assumed. This is a conclusion which has practical as well as theoretical importance."