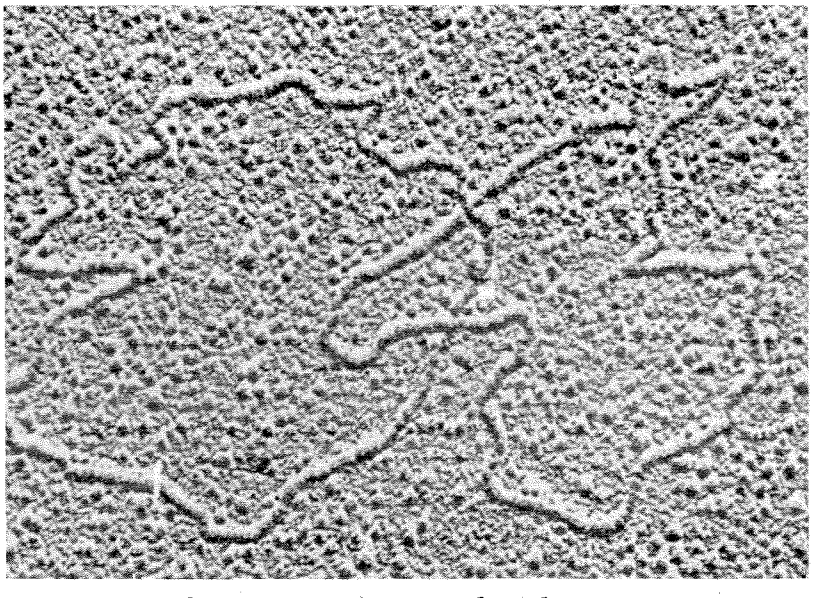
Genetic Chains

Caltech researchers attempt to solve the chemical and biological mysteries of a new form of ring-shaped DNA

Scientists have known for some time that nuclear DNA in animal and plant cells exists as linear molecules. Several years ago, however, researchers found evidence that DNA in certain viruses and bacteria was ring-shaped. This form was also observed in the cells of mice, sea urchins, and men. Now Jerome Vinograd, Caltech professor of chemistry and biology, and his graduate-student colleagues David Clayton and Bruce Hudson have observed these rings in another form—in a series of loops connected like links in a chain. Genetic chains of up to seven links have been found. Located in the mitochondria of several kinds of animal cells, including human, these DNA circles seem to be capable of joining together to form new circles with twice the circumference or of forming interlocking circles in which one link (one molecule) threads through the other, perhaps exchanging genes in the process. The individual circles are generally five microns (1/25,000 of an inch) in circumference and have been found to occur in a variety of different arrangements. Thus a chain of four links can be either linear, as in a normal chain, or branched. There is also the possibility of a circular form, as in a necklace made up of small circles.



Photomicrograph of ring-shaped DNA in a new form—a series of loops connected like links in a chain. Chains of up to seven links have been found in the mitochondria of several kinds of animal cells.

The chain molecules are especially interesting because they contain a new kind of naturally occurring chemical bond. Two or more rings are bonded to each other without the customary sharing of atoms, yet they cannot be separated without breaking covalent chemical bonds.

The biological function of mitochondrial DNA is still essentially unknown. There is evidence that it contains the genetic information for the structural protein in the mitochondrial membranes.

Investigations of Vinograd's research group show that there is a difference in the distribution of the complex forms of mitochondrial DNA depending on the source. Some of the DNA studied came from human cancer cells grown in a tissue culture (HeLa cells) and some from human white blood cells from leukemia patients. The relative amounts of certain kinds of DNA molecules were observed to differ. In one leukemia patient the molecules were 10-micron circles—double the standard size circle. In the same patient only a small fraction of the molecules were linked to form chains of five-micron circles. On the other hand, in the HeLa cells interlocked five-micron circles were found almost exclusively. The next step in the research is to discover the origin of these unusual molecules, how they are formed, and how they affect the mitochondrion and the cell. The questions are difficult, but the answers may reveal new insights into the "code of life."