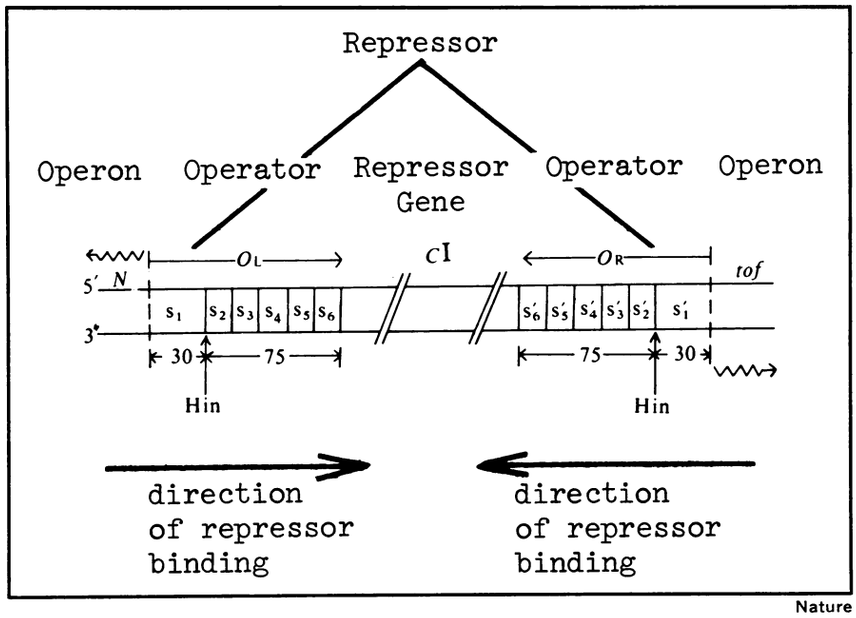
Watchdogs of genes: The repressor shuttle

Anywhere from three up to 500 genes make up the core of viruses. Some thousand genes comprise a bacterium's genetic makeup. Some million genes are present in each of the 180 billion cells of the human body—a staggering number. So it's not surprising that molecular biologists, in their quest to understand genes, are concentrating on viruses and bacteria. Whatever they find in viruses and bacteria presumably applies to higher animals and people as well.

During the past 15 years or so, molecular biologists have discovered, in viruses and bacteria, that gene expression is subject to rigorous controls. Ordinarily an enzyme called RNA polymerase sidles up to a functional gene (operon) and transcribes the message in it into messenger RNA. The messenger RNA then converts the message into a protein (or enzyme). But an RNA polymerase is only able to do its thing if a particular strip of DNA flanking the operon says that it's okay. And whether this "operator" says it's okay or not depends on whether a specific protein is sitting on it or not. This protein is known as a "repressor." If the repressor hops on the operator, gene expression is switched off. If the repressor jumps off the operator, gene expression is turned on.

Repressor-operator-operon interactions are elegant. One repressor can bind one operator that regulates one operon. Or one repressor can bind two operators that regulate two operons. Now two Harvard molecular biologists report in the Nov. 16 NATURE that an operator can consist of multiple repressor binding sites instead of the usual one site. In other words, instead of a repressor sitting on a whole operator all at once, the repressor moves from one end of the operator to the other—like a train chugging down a railroad track. The biologists are Thomas Maniatis and Mark Ptashne. (Ptashne provided, in 1967, the first proof that a repressor acts by attaching itself to DNA.)

The operators Maniatis and Ptashne chose to work with are known as the lambda operators since they are present in a so-called lambda virus. The two operators are controlled by one repressor. Both sit not far from each other on a long strip of DNA. The operators are separated, incidentally, by the gene that makes the protein that represses them. The left operator controls an operon that flanks it on the left. The right operator controls an operon that flanks it on the right. Maniatis and Ptashne have found that



Nature

The lambda repressor binds two operators by moving along them sequentially.

while the two operators differ in their chemical sequences and affinities for the repressor, the affinity of each operator for the repressor is strongest next to the gene it controls.

In other words, when a repressor sits on the left operator (see illustration), it moves from subunits S_1 through S_6 of the operator. When the repressor sits on the right operator, it moves from subunits S'_1 to S'_6.

Why the repressor should plop down on the area of the operator that is closest to the operon is not obvious. In fact, why there should be multiple recognition sites between a repressor and an operator is not all that clear. But it probably has something to do with an operator and repressor keeping an RNA polymerase from transcribing the operon.

Regardless of this possibility, Maniatis' and Ptashne's findings point up one principle of DNA-protein interactions: If an operator has numerous binding sites, a fairly small protein repressor can cover a long stretch of DNA. □

No planet for Barnard's star?

Over the years evidence has been brought forward for planetary companions revolving around two or three stars other than the sun. The first of these was Barnard's star, which had been studied by Peter van de Kamp of Swarthmore College's Sproul Observatory.

The presence of a planet could cause a wobble in a star's motion across the sky (proper motion). Barnard's star is a good place to look for such an effect. It has a very large proper motion (more than 10 seconds of arc per year), which gives room for a wobble to show. Van de Kamp found a wobble with a 25-year period and has postulated at various times one or two planets for Barnard's star.

Now come George Gatewood of the University of Pittsburgh's Allegheny Observatory and Heinrich Eichhorn of the University of South Florida, who report in the October ASTRONOMICAL JOURNAL (just received) that they can't see the wobble.

They studied 241 plates carrying 610 exposures and compared the motion of Barnard's star with those of 18 nearby stars. Eighty of the plates (210 exposures) had been taken with the 20-inch refractor of the Van Vleck Observatory in Middletown, Conn. One hundred and sixty-one plates (400 exposures) had been taken with the 30-inch Thaw refractor of the Allegheny Observatory. The plates were taken over the 55-year period from 1916 to 1971.

The images on the plates were measured on the Strand Automatic Measuring Machine of the U.S. Naval Observatory. Use of the machine permitted greater speed and most likely greater accuracy.

Gatewood and Eichhorn's scrutiny does not find the periodic motion found by van de Kamp. Thus there would be no planet. Van de Kamp is out of the country and unavailable for rebuttal for the present.