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DNA AND TRANSFORMATION

In 1928 another thread of evidence for the chemical nature of the gene came to light when the English bacteriologist Frederick Griffith reported his discovery of something peculiar in pneumococci, the bacteria that cause the most common form of pneumonia, as you might have guessed from the first half of their name. The second half of their name is the bacteriologist's term for bacterial cells that are spherical in shape: cocci (singular, coccus).

Color the heading Pneumococcus and titles and structures A and B.

The normal, disease-causing strain of pneumococci is known as the S strain because it forms very smooth-looking colonies when grown in a culture dish. The smooth appearance is due to a thick, gelatinous *capsule* surrounding the bacteria, which occur mostly in pairs. Griffith also had a mutant strain that could not form a capsule and was relatively harmless. It was called the R strain because the colonies it formed in a culture dish had a rough appearance.

Color the heading Injection and titles and structures C through F.

Griffith inoculated mice with various combinations of the two strains of bacteria, including cells of the S strain that had previously been killed with heat. The *live S strain bacteria* invariably killed the *mice* in a short time, while those of the *R strain* generally did not. When he inoculated some mice with *S strain bacteria* that had been *killed with heat,* the mice suffered no effect at all. But when he inoculated mice with a *mixture* of cells of the *R strain* and *heat-killed cells of the S strain,* the mice invariably died, and live S strain bacteria could be found in large numbers in the tissues of the dead mice. Over the next three years, other scientists found that this "transformation," as it came to be called, could be brought about even in a culture dish, without requiring a host animal to infect. In 1933 the American James Alloway reported that even cell-free extracts of S strain bacteria could cause the transformation. In all of these cases, the S strain bacteria that resulted continued to reproduce thereafter as S strain.

These results made it clear that some substance from the dead S strain bacteria not only gave the R strain bacteria the ability to form a capsule and to cause pneumonia but also changed them genetically so they actually became S strain bacteria and remained so from then on. Whatever that transforming substance was, it obviously changed the heredity of those cells and must therefore be, in effect, a gene.

The discovery of transformation, of course, immediately raised the question, What is the chemical nature of this substance or gene? The principal components of chromosomes were known to be proteins and nucleic acids, and there was general agreement among most scientists that genes were probably proteins. It was thought that nucleic acids probably consisted of repeating sequences of the four nucleotides comprising them and thus were too simple to occur in enough different forms to account for the immense variety of known genes. However, 16 years after Griffith's work, a new discovery led to a reconsideration of nucleic acids.

Color the heading The Transforming Substance and the remainder of the plate as you read.

In 1944, after nearly ten years of painstaking work, three American biologists, Owen Avery, Colin McCarty, and Maclyn McLeod, announced that they had *isolated and purified* the various types of molecules found in S strain pneumococci and tested each one for its ability to accomplish the transformation discovered by Griffith. The only substance that would *transform* R strain cells into S strain cells was a particular kind of nucleic acid, deoxyribonucleic acid, better known today by its abbreviation, *DNA.*

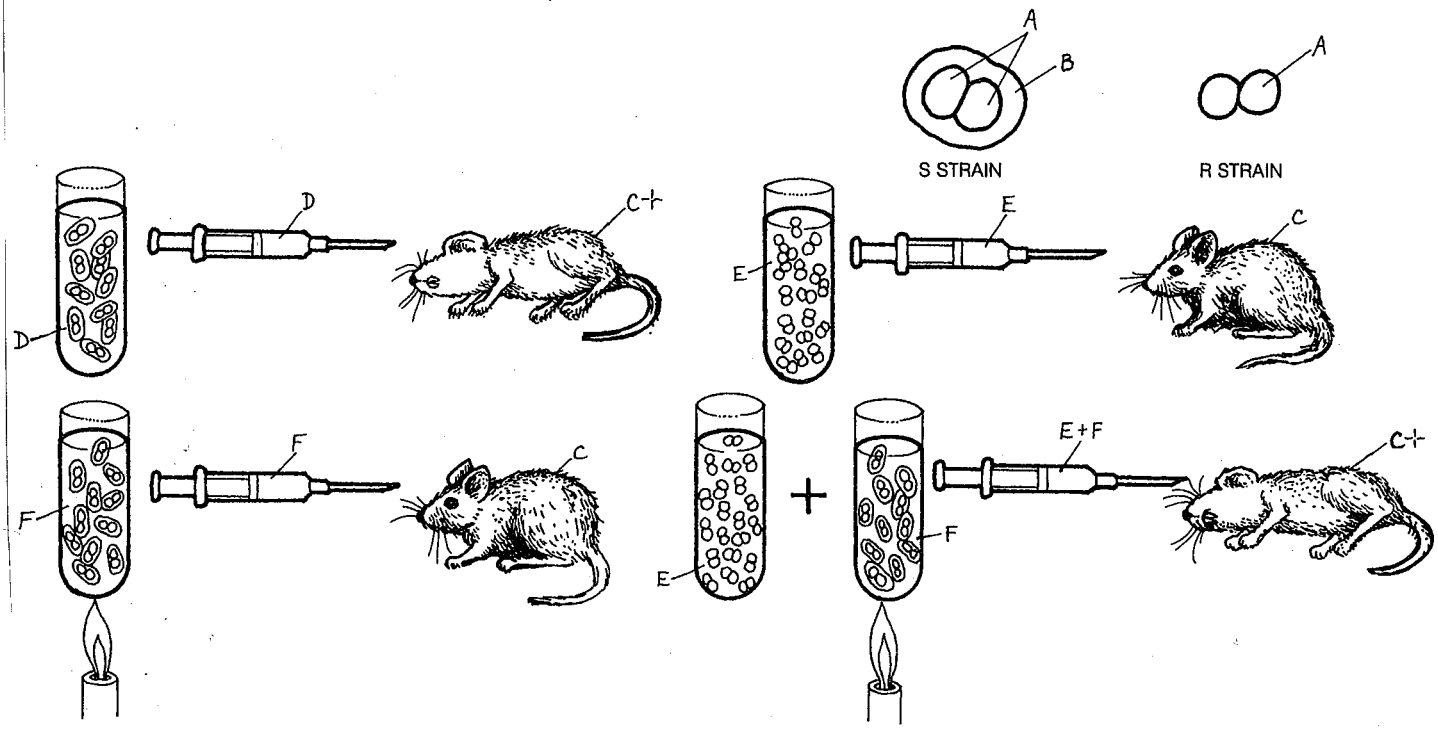
This was not enough to convince everyone that genes were DNA, but it convinced some. DNA began to be taken more seriously, and investigations into its nature increased greatly.

DNA AND TRANSFORMATION.

PNEUMOCOCCUS★
- CELL$_A$
- CAPSULE$_B$

MOUSE$_C$/DEAD MOUSE$_{C+}$

INJECTION★
- LIVE S STRAIN$_D$
- LIVE R STRAIN$_E$
- HEAT-KILLED S STRAIN$_F$



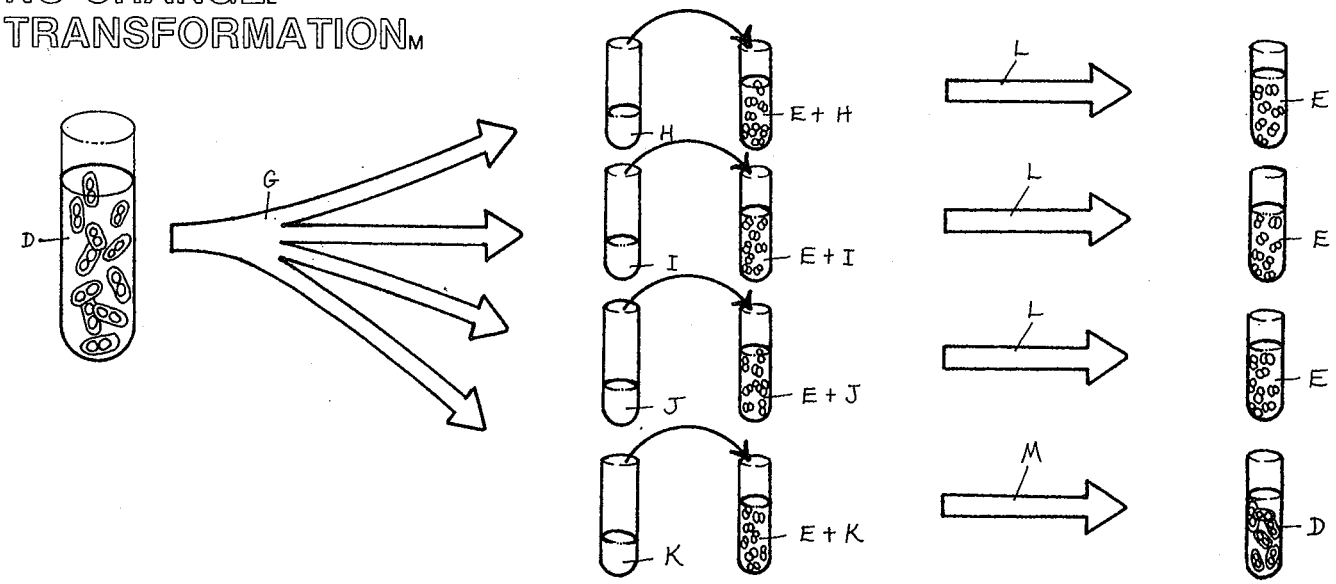
THE TRANSFORMING SUBSTANCE★

ISOLATION AND PURIFICATION$_G$

EXTRACTED S STRAIN MOLECULES★
- PROTEIN$_H$
- CARBOHYDRATE$_I$
- RNA$_J$
- DNA$_K$

NO CHANGE$_L$

TRANSFORMATION$_M$



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