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# Nobel Prize in Medicines 1958


George Wells Beadle


Edward Lawrie Tatum


Joshua Lederberg

**The Nobel Prize in Physiology or Medicine 1958 was divided, one half jointly to George Wells Beadle and Edward Lawrie Tatum "for their discovery that genes act by regulating definite chemical events" and the other half to Joshua Lederberg"for his discoveries concerning genetic recombination and the organization of the genetic material of bacteria"**

One of the most striking features in the development of science during the past two decades is the rapid advance in the diverse fields of biology. Here the tempo of progress continues to quicken. The research contains a vast and complex material whose major portion remains the business of specialists. The observations they make in the laboratories of basic research are apparently distant from the needs of the everyday world. But again and again we discover how short the step is from these basic findings to advances in medical therapy or diagnosis that are of importance to all of us in our daily lives.

For an example we need turn only to the previous Nobel Prize in Genetics, awarded to H.J. Muller for his discovery that X-ray irradiation can change the genetic material in living organisms. The discovery was made, and the detailed analysis carried out, in a type of small fruit fly, and at the time that the prize was awarded, perhaps gave the impression that its greatest interest was in its contribution to basic principles. Now, with the era of atomic energy upon us, we all know that the genetic risks from the high-energy radiation threatening man, belong to the things I just mentioned, of vital and immediate importance to us all.

Experimental genetics is a branch of modern biology in which progress has been especially rapid. The methods and points of view of this and its allied disciplines are indispensable for many fields of medicine today. This rapidly increasing importance of experimental genetics and cell research is easily understood. The research is now reaching towards the very elements of heredity, the structures within each cell that control its life and its behavior, and thus ultimately determine the development of the whole organism. Now we begin to see what the fundamental biological processes may be. That discoveries in this field have consequences in many others is surely no surprise to any of us.

The work of all three winners of the prize lies on this plane. Their studies are concerned with the very basis of heredity and the manner in which the genes function. That hereditary characters are transmitted from parents to offspring via special elements in the ovum and spermatozoon, the so-called genes, has long been known. The organism that develops from the fertilized ovum receives certain of the parents' characters through these genes, and the genetic material in the fertilized egg, that is to say, all these genes combined, determines the development of the organism.

The cells that together constitute an organism as a rule contain a complete set of genes characteristic of the species. In ordinary cell division these are divided and subsequently distributed equally between the two daughter cells. At fertilization, the different genetic materials from two individuals unite in the fusion of the egg and the sperm. The result of the sexual reproduction is to provide offspring with genes from both of their parents. In this way, individuals with differing combinations of characters originate. And just herein lies the biologic value of the sexual process, which can be traced throughout practically the entire animal and plant kingdoms. Without the renewal such a

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constant recombination of characters involves, an animal or plant species would not be able to survive the struggle for existence.

The characters, which are transmitted by the genes from generation to generation, present a picture of bewildering multiplicity. This very multiplicity of the genes' effects made it difficult to attack experimentally the problem of their structure and manner of functioning; it was impossible to trace straightforward lines that could serve as a background for an experimental study.

The situation was radically changed by Beadle and Tatum, who, through a daring and astute selection of experimental material, created a possibility for a chemical attack upon the field. Circumstantial evidence pointed to a similarity of the genetic mechanisms throughout the entire plant and animal kingdoms. Beadle and Tatum selected as object for their investigations an organism with very simple structure, a bread mold, Neurospora crassa, which is far easier to work with, in many respects, than the objects usually studied in genetics. It is able to synthesize its body substances from a very simple culture medium: sugar, salts, and a growth factor. When cultures of the mold are exposed to X-ray irradiation, mutations - that is, changes in individual genes - result as they do in other organisms. By producing a large number of such mutations and by means of an analysis of the material, which should serve as a model for analytic research, Beadle and Tatum succeeded in demonstrating that the body substances are synthesized in the individual cell step by step in long chains of chemical reactions, and that genes control these processes by individually regulating definite steps in the synthesis chain. This regulation takes place through formation by the gene of special enzymes. If a gene is damaged, for example through irradiation-induced mutation, the chain is broken, the cell becomes defective - and may possibly be unable to survive. Even in the formation of comparatively simple substances the steps in the synthetic chain are many, and consequently the number of collaborating genes large. This explains simply why gene function appeared to be so impossibly complex. The discovery provides our best means of penetrating into the manner

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in which the genes work and has now become one of the foundations of modern genetics. Its importance extends over other fields as well, however.

Especially valuable is the possibility it affords for detailed study of the processes of chemical synthesis in the living organism. In Neurospora material it is easy by means of X-ray irradiation to produce quickly a large number of strains in which the function of different individual genes has been disturbed. By comparing these strains we are able to determine in detail how the different stages of synthesis succeed one another when the cell's substances are formed. Beadle and Tatum's technique has become one of our most important tools for the study of cell metabolism and has already yielded results of significance to various problems in the fields of medicine and general biology.

The successful results with Neurospora also provided an incentive to continued efforts to probe the basic processes further with the aid of even simpler organisms. The bacteria are even more primitive than Neurospora. The bacterial genetic mechanism was little known; many even doubted that they had one comparable with that of the higher forms of life. Tatum extended the approaches worked out in Neurospora to the bacteria. When Lederberg came to Tatum's laboratory as a young student, they discovered that different bacterial strains could be crossed to produce an offspring containing a new combination of genetic factors. This is the counterpart of the normal sexual fertilization in higher organism; it is usually considered preferable here, however, to speak of «genetic recombination». Bacterial genetics has been developed, primarily through the efforts of Lederberg and his coworkers, into an extensive research field in recent years. He also contributed further evidence that the genetic mechanism of the bacteria corresponds to that of the higher organisms. Moreover, thanks to their simple structure and extraordinarily rapid growth, bacteria provided new and excellent possibilities for a more profound study of the genetic mechanisms. Lederberg has made many contributions in this field. Particularly important is his discovery that sexual fertilization is not the only process leading to recombination of characters in bacteria. Bits of genetic material can, if they are introduced into the bacterial body, become part of the genetic material of the bacterial cell

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and thus change its constitution. This is usually termed «transduction», and it is the first example demonstrating that it is possible experimentally to manipulate an organism's genetic material and to introduce new genes into it and, the organism new characters. Studies in this are now being carried out in many laboratories in different parts of the world.

The transduction process and certain other related phenomena have greatly improved our means of penetrating experimentally into the basic processes of cell function and cell growth. In all probability they will also prove to have great significance in the study of the function of the higher organisms under normal and pathologic conditions. Work in this field, carried out in laboratories throughout the world, has already greatly expanded our knowledge of the basic processes in bacteriophage infection and of the mechanism of virus infection. The observations also have opened the way to a more profound understanding of certain growth problems. Certainly cancer research will be increasingly influenced by the evolution of our knowledge of the organization of the genetic material and its manner of functioning, that has been made possible by the discoveries of this year's three winners of the Nobel Prize in Physiology or Medicine.

***For more details please visit:***

http://www.nobelprize.org/nobel_prizes/medicine/laureates/1958/press.html