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Jacques Monod – A theorist in the era of molecular biology / Un théoricien à l'ère de la biologie moléculaire

Science and the applications of science from Louis Pasteur to Jacques Monod



La science et les applications de la science de Louis Pasteur à Jacques Monod

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ABSTRACT

Jacques Monod's ideas on the applications of science came within the scope of a long tradition at the Institut Pasteur. Louis Pasteur, whose scientific career was characterized by a permanent come and go between science and its applications, long opposed the idea of getting any income from his research, until the financial needs of the Institut Pasteur made him change his mind. As for Jacques Monod, he remained a fervent supporter of basic science during his whole scientific career. However, once he became director of the Institut Pasteur, he realized that the applications of research had to be developed to support the institute from a financial point of view. Thus, he reorganized the valorization of research in the institute, through an incitation of scientists to develop projects with possible applications, and by creating a company, Institut Pasteur Production, for which he had a factory built, and which was in charge of producing and commercializing the vaccines and reagents stemming from the research at the Institut Pasteur.

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RÉSUMÉ

Les idées de Jacques Monod sur les applications de la recherche se sont inscrites dans la tradition pasteurienne. Louis Pasteur, dont la carrière a été marquée par un va-et-vient continu entre la recherche et ses applications, a longtemps été opposé à l'idée selon laquelle les applications pourraient apporter des revenus, jusqu'à ce que la nécessité de financer l'Institut Pasteur le fasse changer d'avis. Jacques Monod fut, quant à lui, durant sa carrière scientifique, un fervent défenseur de la recherche dite fondamentale. Devenu directeur de l'Institut Pasteur, il prit conscience de la nécessité de développer la valorisation de la recherche afin d'en tirer des revenus. Cela l'a conduit à réorganiser ce secteur en incitant les chercheurs à rechercher et développer des applications de leurs travaux et en créant une société, Institut Pasteur Production, qu'il a dotée d'une usine et a chargée de produire et commercialiser les vaccins et réactifs issus de la recherche pasteurienne.

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1. Introduction

When Giuseppe Baldacci asked me to give a talk during the commemoration of the 100th birthday of Jacques Monod from which this text is issued, I could not refuse. Indeed, Jacques Monod was my mentor. He welcomed me in his laboratory at the beginning of my career, thus proceeding to turn a student coming from the École polytechnique into a molecular biologist, something which had never been done before. Then, the confidence he never ceased to grant me was of immense importance to me. Finally, at an early stage, and without letting me know, he decided that I should later become a director of the Institut Pasteur, and he must have been able to convince his entourage, since this is exactly what happened 12 years after his demise. Therefore, how could I have refused to pay homage to his memory?

I was asked by Giuseppe Baldacci to recall in what Jacques Monod's ideas were concerning the relations between biological research and their socio-economic applications. Since the ideas of Jacques Monod on this matter emerged from a long tradition at Institut Pasteur, I will start by recalling Louis Pasteur's view on the subject before analyzing Monod's. I will end by a few words on the "after Monod", to show the influence he had on what is now called "la valorisation de la recherche", i.e. the development of the applications of research.

2. Louis Pasteur

2.1. The patron saint of biotechnologists

For many, Pasteur is the precursor and model, the patron saint, of biotechnologists. Indeed, was it not upon a request from a Lille manufacturer that he started his much celebrated work on fermentation? Did he not follow up this work to improve the manufacture of vinegar, wine and beer? And, if he started working on infectious diseases, was it not to help first French sericulture confronted with a mysterious disease of silkworms, and then cattle breeders, who saw their cows and sheep decimated by anthrax? And if he became interested in vaccines, it was obviously to protect humanity against plague, cholera, and several other scourges.

2.2. The basic scientist

But then, if Pasteur was only interested in finding solutions to practical problems, why did he make the following declaration to the students while inaugurating, in 1854, the faculty of Sciences at the University of Lille?

"It will be up to us, especially, not to share the opinion of these narrow minds that disdain all that in the sciences has no immediate application. You know the charming word of Franklin. He attends the first demonstration of a purely scientific discovery, and is being asked: 'What will be its use?' Franklin answers: 'Of what use is the child just born?'" [1]

Is this the language of a hard line biotechnologist?

All the same, when he writes several years later, in 1865:

"It is unique to scientific discoveries to surpass one another. The field of science is inexhaustible. The more it is ploughed, the greatest are the treasures it reveals" [2].

When he says so, he knows what he is speaking about. He describes the deep pleasure, almost sensual, that a scientist feels when he succeeds in increasing human knowledge, similar to that felt by a painter achieving a work of art.

His work on tartaric acid and his amazing intuitions on molecular dissymmetry, his refutation of spontaneous generation, his reflections on virulence factors and mechanisms of immunity were, more than anything, motivated by his desire to understand, common to all true scientists.

2.3. Science and the applications of science

Therefore, and this is why he constitutes a model, Pasteur was at the same time, using expressions that he refuted, an "applied scientist" and a "basic scientist". In his mind, the will to control Nature for practical uses and the desire to increase knowledge always co-existed. If one looks carefully, his scientific career was characterized by a permanent come and go between the search for solutions to practical problems and reflections on theoretical questions.

If he answered the request of the manufacturer in Lille, it was because his theoretical work on tartaric acid had aroused his interest in fermentations, tartaric acid being a side product of such a process. Conversely, his applied work on fermentations led him to wonder about the origin of the microorganisms responsible for these phenomena and thus to tackle the very theoretical question of spontaneous generation, and of the origin of life.

This is really the lesson taught by Pasteur, summarized in this famous sentence:

"There is no kind of science that could be given the name of applied science. There is science and the applications of science, bound to each other as the fruit to the tree that bore it" [3].

Science and its applications fertilize each other. The tree gives the fruit and the fruit gives the tree. Applications result from the advancement of science and the search for applications brings to light new theoretical questions that science must solve.

A corollary is that fruitful applications can only derive from good science.

This message is simple, and the debate should have been closed. However, this is not the case. The pressure is high from industrialists, from many politicians and a great part of the general public, that science be conducted only because of its applications. This is why, as we shall see, Jacques Monod, in his turn, will have to drive this point home.

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